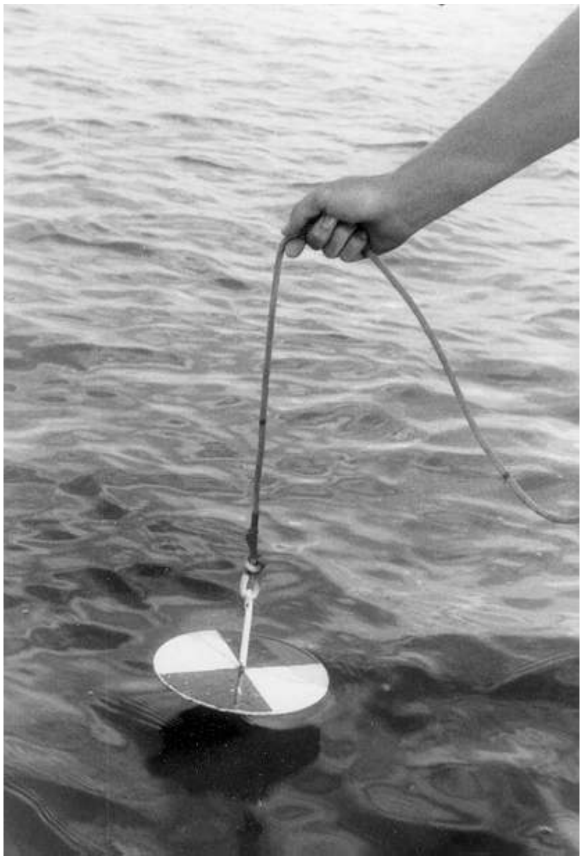

Final Report to the U.S. Bureau of Reclamation – February 2005

Phase II: Limnological and Fisheries Investigation of Lake Pleasant

Cooperative Agreement
No. 00-FC-32-0160
United States Bureau of Reclamation
Phoenix Area Office

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Research Branch
Arizona Game and Fish Department
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Phoenix, Arizona 85023

Arizona Game and Fish Department Mission
To conserve, enhance, and restore Arizona's diverse wildlife resources and habitats through aggressive protection and management programs, and to provide wildlife resources and safe watercraft and off-highway vehicle recreation for the enjoyment, appreciation, and use by present and future generations.

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Arizona Game and Fish Department

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List of Scientific Names
(of species collected in Lake Pleasant 1987-2004)

Species	Scientific Name
Yellow Bullhead	*Ameiurus natalis*
Goldfish	*Carassius auratus*
Sonora Sucker	*Catostomus insignis*
Common Carp	*Cyprinus carpio*
Red Shiner	*Cyprinella lutrensis*
Threadfin Shad	*Dorosoma petenense*
Mosquitofish	*Gambusia affinis*
Channel Catfish	*Ictalurus punctatus*
Green Sunfish	*Lepomis cyanellus*
Bluegill	*Lepomis macrochirus*
Redear Sunfish	*Lepomis microlophus*
Sunfish Hybrid	*Lepomis spp*.
Largemouth Bass	*Micropterus salmoides*
White Bass	*Morone chrysops*
Striped Bass	*Morone saxatilis*
Golden Shiner	*Notemigonus crysoleucas*
White Crappie	*Pomoxis annularis*
Black Crappie	*Pomoxis nigromaculatus*
Flathead Catfish	*Pylodictis olivaris*
Tilapia	*Tilapia spp*.

INTRODUCTION

Increasing water demands in the Southwest prompted the United States Congress to authorize the Bureau of Reclamation (USBR) to create the Central Arizona Project (CAP) in 1968 (Public Law 90-537). The primary purpose of the CAP was to provide Colorado River water, through a series of aqueducts and canals, to central and southern Arizona for municipal, industrial, and agricultural use. Plans for CAP also included the construction of a regulatory storage unit that would improve operating flexibility and efficiency by allowing the importation of greater quantities of Colorado River water in years when it was in surplus (USDI 1984). After considering a number of alternatives, the Secretary of the Interior selected a plan (Plan 6) that included the construction of New Waddell Dam, which would effectively increase the size of an already existing reservoir, known as Lake Pleasant. Using Lake Pleasant to store this new water source was a rational choice because of its proximity to the large metropolitan area of Phoenix, the low impacts to Native American tribes and to the environment, and the strong public support for the plan (USDI 1984).

Prior to construction of New Waddell Dam, concerns arising from the 1984 Environmental Impact Statement (USDI 1984) regarding project related changes to reservoir operating regimes, water quality, fish species composition, and potential impacts to the recreational fishery, prompted the initiation of several research studies. These studies were designed to address concerns related to post-dam construction which included: 1) increased salt loading, 2) changes in various water quality components, 3) increased reservoir eutrophication potential, 4) effects of water level fluctuation on fish spawning success, and 5) potential for the introduction of new fish species. In addition, reasonable and prudent alternatives identified by the U.S. Fish and Wildlife Service in 1984 required information relative to the potential effects that changes in reservoir operation may have on breeding bald eagles.

Studies related to the quality and composition of water entering the CAP canal system from Lake Havasu were conducted in the late 1980's to address some of the concerns identified above. These studies included an evaluation of the intake reservoir for the CAP (Roline and Lieberman 1985); entrainment potential of fish in the CAP canal (Mueller 1990); and the potential for establishing new fish species from the CAP in Lake Pleasant and the Salt River (Grabowski et al. 1984).

In addition, a multi-phased research project was designed to examine the effects of dam operations and enlargement of the reservoir on the limnology and fisheries in Lake Pleasant. The USBR made a commitment to mitigate for adverse impacts to the sport fishery in Lake Pleasant based on results of this study.

Phase I of the research project was conducted prior to the construction of New Waddell Dam (July 1987 to September 1989) to gather the baseline limnological and fisheries data in Lake Pleasant necessary to conduct comparative post-construction analyses (Morgensen 1990).

As typical with many new reservoirs, Lake Pleasant was expected to go through a period of "trophic disequilibrium" (Kimmel and Groeger 1986). This period begins with a "trophic upsurge", typified by an influx of nutrients from the flooded basin, an abundance of habitat and food for benthic organisms, and a rapidly expanding lacustrine environment (Benson 1982). This initial period of high productivity often produces false hopes for a higher level of fisheries production than can be sustained. The upsurge is followed by a "trophic depression" which is caused by decreased nutrient loading and a reduction of favorable habitat. Fish populations fluctuate drastically during this state of disequilibrium, but often stabilize within 5-10 years of dam completion (Adams et al. 1983).

Phase II was projected to begin 5-7 years after the completion of the dam (1997 - 1999), when the reservoir was expected to exhibit characteristics of "trophic equilibrium" (Hutchinson 1973; Adams et al. 1983). However, yearly water fluctuations of up to 50 m and land use practices within the watershed (e.g. agriculture and residential development) have kept the reservoir in a state of disequilibrium and it is unlikely that it will ever experience a long-term stable state. Therefore, Phase II began in 2000, when the reservoir likely reached a state of dynamic trophic equilibrium, consisting of episodic fluctuations around an average productivity level (Kimmel and Groeger 1986).

The purpose of Phase II of the research project was to document changes in fish species composition, water quality, and angler success as a result of the construction and operation of New Waddell Dam. Therefore, the primary objective addressed in Phase II of the study was to compare current conditions (described above) with pre-New Waddell Dam conditions (Phase I). Secondary objectives included: 1) describe current angler preferences, pressure (effort), catch and harvest, success, and satisfaction on Lake Pleasant, 2) describe the composition, size structure, and relative abundance of fish species in Lake Pleasant, and 3) describe water quality conditions in Lake Pleasant. Based on findings from the above objectives, mitigation alternatives are presented to USBR for consideration.

STUDY AREA

Since completion of New Waddell Dam in 1992 and subsequent filling of Lake Pleasant in 1994, the reservoir has increased in size nearly three-fold; from 3,760 surface acres to 9,970 surface acres. The maximum storage capacity has increased from 157,600 acre-feet to over 1.1 million acre-feet (817,900 acre-feet at conservation pool). Shoreline distance increased from just over 50 miles to 114 miles. The original dam (Carl Pleasant Dam, and later named Waddell Dam) was once the largest multiple arch dam in the world, but is now dwarfed by the zoned earthfill New Waddell Dam that is nearly 1.4 km long and 134 m high.

Prior to construction of New Waddell Dam, the reservoir received the majority of its water input from the Agua Fria River and other small tributaries at the north end of the reservoir (Figure 1). Since becoming a regulatory storage reservoir, Lake Pleasant is now primarily filled by CAP water at the south end of the reservoir. Water is transported from the Colorado River (Lake Havasu) via the CAP Hayden-Rhodes aqueduct and Waddell Canal (Figure 2). A pumping-generating plant at the base of New Waddell Dam pumps water into Lake Pleasant during winter (November – April) and out of the reservoir during summer (June – October). The Agua Fria River and several other small

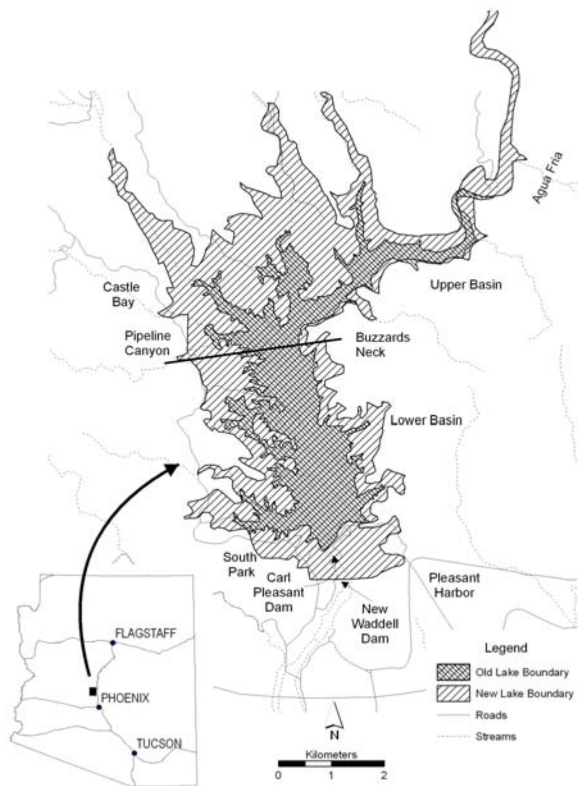

Figure 1. Map of Lake Pleasant before and after the construction of New Waddell Dam. The line from Pipeline Canyon to Buzzards Neck divides the upper and lower basin. Exit interviews (angler surveys) in Phase II were conducted at boat ramps at South Park, Pleasant Harbor, and Castle Bay.

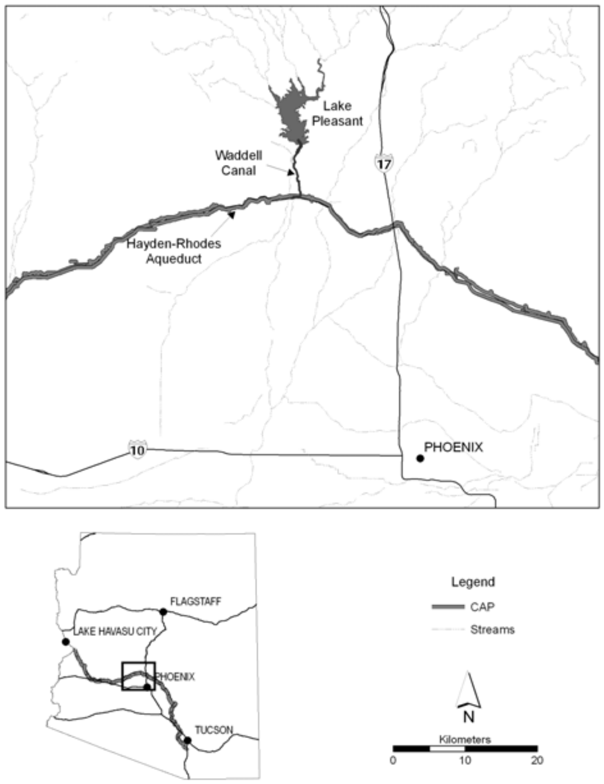

Figure 2. Map of the CAP canal system, including the Regulatory Storage Unit, Lake Pleasant.

tributaries continue to provide seasonal inflow in the upper portion of the reservoir, especially during spring runoff.

Lake Pleasant Regional Park also increased in size with the creation of the larger reservoir. While the previous park had only one boat ramp, the new park has four multi-lane boat ramps. A full service marina, 675 picnic and camp sites, and a multitude of other amenities help make Lake Pleasant Regional Park one of the most visited parks in Arizona. The large, deep reservoir now provides opportunities for water sports enthusiasts that were not previously available. The enlargement of the reservoir has also increased the angling opportunities for the public by inundating vegetation and other structures, increasing the number of coves, and enhancing habitat.

For sampling purposes, Lake Pleasant was stratified into two basins by an imaginary line extending from the peak on Buzzard's Neck to the high point in Pipeline Canyon (Figure 1). The upper basin is composed of numerous embayments and tributaries, including the Agua Fria River, Humbug Creek, Coles Wash and Castle Creek. It has both gradually sloping shorelines and steep cliff walls. Submerged trees and other debris are common in and around embayments. Because the upper basin is primarily influenced by flows from the Agua Fria River and runoff from various washes and creeks, it tends to be more productive than the lower basin (Walker 1998). The diverse habitat and high productivity create excellent fishing opportunities in the upper basin, and as a result, a large portion of the total angling pressure on the reservoir.

The lower basin includes the major deep portion of the reservoir. Water from the Colorado River is both pumped into and released from gates located near the dam, which creates limited mixing between the two basins (Walker 1998). Although there are a number of embayments, shorelines are typically steep-sided. Numerous islands, which appear when water levels are low (August – October), provide excellent fishing opportunities. Three of the four primary boat launches, including the marina, are located in the lower basin; therefore, it receives a majority of the water sport and recreational boat traffic.

METHODS

Angler Surveys

Angler survey data were used to describe angler preferences and satisfaction, as well as estimate pressure (effort), catch and harvest, and success at Lake Pleasant. Survey questions were the same as those asked in Phase I, but the survey design changed slightly with the increase in access points as a result of enlargement of the lake. In Phase II, rather than just a single access point (as sampled in Phase I), we randomly sampled the three primary access points. In addition, few roving surveys were conducted in Phase I (typically for the purpose of collecting length/weight data from anglers). In Phase II we relied heavily on roving surveys to collect data from shore anglers and Agua Fria anglers that would normally be missed with access point surveys.

Survey Intensity and Approach

The total number of survey days was based on sample means and variances obtained during Phase I. Power analysis software (SamplePower 2.0, SPSS) was used to determine that 284 days were needed to detect at least a 20% change in overall angler CPUE (α = 0.05 and β = 0.20) between Phase I and Phase II. The 284 days were divided evenly throughout the four-year study (71 days per year). Eighty percent of the total number of survey days were randomly chosen for exit interviews at the three main boat ramps; the remaining 20% were chosen randomly for roving interviews.

The initial year of angler surveys (2001) was treated as a "pilot" because season, day-of-week, and time-of-day (strata) were assigned based on angler use estimates from expert opinion (Appendix 1a). After analyzing data collected in 2001, strata were adjusted so that angler use estimates during 2002-2004 reflected data collected during the previous year (Appendix 1b-1d). Also during 2002-2004, the total number of survey days was adjusted to ensure that all strata were sampled sufficiently (at least once). As a result, the number of survey days ranged from 71 during 2001 to 94 in 2004. Survey periods were reduced from six hours in 2001 to four hours in subsequent years (2002-2004) to improve the quality of data by reducing creel clerk boredom (Pollock et al. 1994).

For exit interviews (completed trip surveys), one of three defined access points (South Park, Castle Bay, and Pleasant Harbor; Figure 1) was selected each sampling day using a nonuniform sampling probability (Pollock et al. 1994). Sampling probabilities were adjusted each year to more closely reflect actual use from the previous year (Appendix 2). The creel clerk was stationed at the boat ramp where each party exiting the particular area was interviewed.

Since shoreline anglers could not be effectively interviewed through access surveys, we conducted roving surveys to interview anglers fishing from shore. Shoreline roving surveys (incomplete trips) began by making a progressive count of all shore anglers on the south and west sides of the lake (only accessible shoreline) in a clockwise direction. At the completion of the count, the clerk interviewed all shore anglers while proceeding in a counter-clockwise direction. A second count was conducted at the end of the creel day and the two counts were averaged to estimate total fishing effort (Pollock et al. 1994).

The Agua Fria was sampled independently during the Bald Eagle closure period (December 15 - June 15), utilizing a roving survey because anglers did not use a specific access point and could not access the area via the main lake (during the closure period, anglers access the Agua Fria River using various dirt roads and trails). Surveys were conducted similarly to shoreline roving surveys, except that progressive counts included all boat and shore anglers upstream of the eagle closure buoys. All anglers were approached by boat and interviewed.

Regardless of the method of survey, anglers were asked a series of questions, including questions for the entire group: 1) number of anglers in group, 2) start time and end time (exit surveys) or hours fished at the time of the interview (roving surveys), and 3) rating of the fishing experience (1-4, 4 being best). Individuals in the group were asked: 1) age (adult or < 15 years old), 2) species sought, 3) number of each species caught, and 4) number of each species harvested.

Gate Counts

When there are multiple access points on a lake, extrapolation of angler survey data to estimate effort, catch, and harvest for the entire lake is most accurate when there is an account of the number of anglers using each entry point. Visitor information at Lake Pleasant is collected through a fee-based system by Lake Pleasant Regional Park (South Park and Castle Creek) and the Maricopa County Water Conservation District (Pleasant Harbor). However, this information does not identify the specific use of the lake by visitors (i.e. the number of anglers is not identified). Therefore, we conducted gate counts in 2002 and 2004 to estimate the number of anglers visiting the lake on a given day. Counts were stratified by season, time of day, and day of week (48 total counts each year). The clerk was stationed at a randomly selected entry gate and all vehicles were stopped upon entry. Drivers were asked how many people in the vehicle would be fishing on that particular day. The estimates from the two years were averaged for use in calculations described below.

Data Analysis

The parametric tests described for each segment of the objective below are robust enough to overcome violations of the assumptions (Zar 1996), especially since sample sizes were so large. All statistical tests were considered significant at $P < 0.05$ (based on power and sample size considerations described above).

Angler Preferences

Angler preferences were categorized according to the species sought by the angler on the day of the interview: 1) largemouth bass, 2) white bass, 3) striped bass, 4) largemouth bass plus other species, 5) white bass plus other species, 6) striped bass plus other species, 7) crappie, 8) sunfish, 9) catfish, and 10) anything. Due to potential errors in species identification by anglers, black and white crappie were combined into a single "crappie" category, all *Lepomis* spp. were combined into a "sunfish" category, and flathead and channel catfish were classified as "catfish". When anglers stated a preference for more than one species (categories 4, 5, 6, and 10 above), angling effort for a single species could not be determined; therefore those groups were combined into a "multiple species" category for analyses. Chi-square tests were used to determine differences in species preferences among years (Phase II) and between phases.

Angling Pressure

Angling pressure (or effort) is a measure of the use of a resource by anglers, typically measured in angler-hours. Pressure estimated from exit surveys was calculated as a direct expansion of the information obtained in the interview (Pollock et al. 1994). Daily fishing effort at an access point was calculated based on start and stop times for each group exiting the lake. Whole lake estimates of daily fishing effort ($\hat{E}$) were extrapolated from effort at the single access point by adjusting the data for time period (Appendix 1) and site selection probabilities (based on actual gate counts) using the following equation:

$$\hat{E} = \sum_{i=1}^{n} \left(e_i / \pi_i \right) \qquad (1)$$

where e_i = fishing effort (hours) for the ith sampling unit, and π_i = total probability that the ith sample unit is included in the sample (in this case, time period probability multiplied by site selection probability equaled total probability). We used data collected from gate counts to determine site selection probability, since they were more accurate than expert opinion (used to determine number of sample days in Appendix 2) to calculate total probability.

Roving creel survey effort ($\hat{e}$; for a fishing period) was estimated by:

$$\hat{e}_i = I_i \times L \qquad (2)$$

where I_i = the mean progressive count of anglers for day i, and L = length of the fishing period (survey length). Daily fishing effort ($\hat{E}$) for the survey period was adjusted for period probability:

$$\hat{E} = \sum_{i=1}^{n} \left(\hat{e}_i / \pi_i \right) \qquad (3)$$

where π_i = total probability (in this case, equivalent to time period probability) that the ith sample unit is included in the sample (Appendix 1).

For both access and roving surveys, daily angling effort was multiplied by the number of days in each stratum to determine total effort for each stratum. Variance and standard error were calculated for estimates using equations presented in Pollock et al. (1994). The overall mean angler day was compared among years using ANOVA, and among phases using t-tests.

Morgensen (1990) also measured fishing pressure as the number of anglers, rather than angler-hours. Therefore, we also estimated the daily number of anglers (A) by:

$$\mathrm{A} = \mathrm{T} \times \mathrm{P} \times \mathrm{M} \qquad (4)$$

where T = total number of vehicles entering park (based on gate counts), P = percentage of all vehicles with anglers, and M = mean number of anglers per vehicle (only those vehicles with anglers). Estimated mean yearly number of anglers was compared between phases using a t-test

Whole lake estimates of angling pressure were calculated for each phase from exit interviews only.

Angler Catch and Harvest

Individual angler catch per unit effort (catch rate) was measured in two ways. The first was the total ratio estimator (Malvestuto 1996), which was calculated as total catch (or harvest) divided by total effort for all anglers. This estimate was used by Morgensen (1990) to compare catch rates across Arizona. The estimate is very basic, and is generally thought to be inaccurate because it does not account for variation in individual angler catch rates (it cannot be statistically compared because there is no variance associated with the estimate). Both incomplete and completed trips are used in the calculation. The total ratio estimator was used only for comparison purposes with data collected in Phase I.

The second, and more accurate method for calculating CPUE is the mean of ratios estimator (Pollock et al. 1997). CPUE was calculated with the equation:

$$CPUE = \frac{1}{n} \times \sum_{i=1}^{n} \left(\frac{C_i}{L_i} \right) \qquad (5)$$

where C_i = catch for the ith angler, L_i = trip length for the ith angler, and n = number of anglers. Only data collected from completed trip interviews (access surveys) is used for reasons outlined in Pollock et al. (1997). Similar calculations were used to determine harvest rates.

Anglers in the 21st Century have become very specialized, and do not often catch fish of a species not targeted. Therefore, catch rates of targeted species may be a better indicator of the status of the fishery than catch rates with all anglers combined. Yearly catch rates of targeted species (Phase II) were compared using analysis of variance (ANOVA). T-tests were used to determine differences in catch rates between phases.

Whole lake estimates of daily catch were calculated similarly to estimates of fishing effort

(Equation 1). Daily catch ($\hat{C}$) for access surveys (completed trip) was estimated by:

$$\hat{C} = \sum_{i=1}^{n} \left(c_i / \pi_i \right) \quad (6)$$

where c_i = catch for the ith sampling unit, and π_i = total probability that the ith sample unit is included in the sample (in this case, time period probability multiplied by site selection probability equaled total probability).

The mean of ratios catch rate estimator (Equation 5) was used in the following equation to determine whole lake daily catch ($\hat{C}$) for incomplete trips (roving surveys):

$$\hat{C} = \hat{E} \times CPUE \quad (7)$$

Total catch in each stratum was estimated by multiplying the estimate of daily catch ($\hat{C}$) by the number of days in the stratum. Variance and standard error were calculated for catch estimates using equations presented in Pollock et al. (1994). Harvest estimates were calculated in the same manner.

Angler Success

Biologists sometimes disagree as to the definition of a successful angler. Some argue that simply catching a fish means that an angler is successful, others argue that the angler must catch a fish of the species that is targeted to be considered successful. We report both overall success (any fish) and targeted species success. Only completed trip interviews (access surveys) were considered, since incomplete trips (roving surveys) may bias success estimates. Overall success (S) was calculated by:

$$S = \left(a/t \right) \times 100 \quad (8)$$

where a = the number of anglers catching at least one fish and t = total number of anglers. Percent angler success for anglers targeting a specific species ($\hat{S}$) was calculated as:

$$\hat{S} = (\hat{a}/\hat{t}) \times 100 \quad (9)$$

where $\hat{a}$ = number of anglers catching at least one individual of the targeted species, and $\hat{t}$ = total number of anglers fishing for the targeted species. Chi-square tests were used to determine differences in angler success among years and between phases.

Angler Satisfaction

Anglers were asked to rate their fishing experience (for the day of the interview) as 1) poor, 2) fair, 3) good, or 4) excellent. Differences in satisfaction ratings were compared among years and between phases using chi-square. The overall mean rating for each year was compared using ANOVA. Overall ratings were compared between phases using a t-test.

Population Dynamics

Fish collection data was used to describe the current status of fish populations in Lake Pleasant. Because not all species are adequately sampled by a single collection method, it was necessary to target specific species with specific gear (Bettross and Willis 1988). In Phase I, Morgensen (1990) used a combination of gill netting, electrofishing, and cove rotenone to evaluate the status of the fishery. In Phase II, we did not use cove rotenone due to increased costs, regulatory pressure, and most importantly, public opposition to the procedure (Bettoli and Maceina 1996).

Seasonal variation (especially in relative abundance and condition factors) in population dynamics can bias sampling data (Guy and Willis 1991). Although budgetary restraints did not allow us to sample quarterly as in Phase I, we were able to sample during spring (May) and fall (November) so that seasonal biases could be identified.

Sample Site Selection

The 78 sites used for fish sampling during Phase I (Morgensen 1990) were not used because most of them are now located in pelagic areas of the lake (see Figure 1); areas where fish density and composition is not representative of the entire reservoir. Therefore, we used current reservoir maps to determine sampling locations in Phase II. From November 2000-May 2001 we used a map of Lake Pleasant generated at conservation pool, and identified shoreline points at 500-m intervals (Appendix 3a). Each of the points was numbered and considered a potential sampling site. For the remainder of the study, we increased the accuracy of our points by mapping the shoreline with GPS at both high and low water levels (Appendix 3b-3c). Potential sampling sites were identified at 500-m intervals.

The appropriate number of sample sites (as described below) was determined using power analysis (SamplePower 2.0, SPSS) based on data collected in November 2000 and May 2001. The number of sites sampled from November 2001-May 2003 allowed for the detection of a 30% (gill netting) or 50% (electrofishing) change in CPUE ($\alpha = 0.10$ and $\beta = 0.20$) between Phase I and Phase II. These values represent the best precision that could be obtained based on budgetary and time constraints.

Gill Netting

In November 2000 and May 2001, we sampled 12 sites (six in each basin) with gill nets. In subsequent sampling trips, the number of sites was increased to 20 (ten in each basin) in an effort to decrease the variance of our samples and gain precision in our estimates. Sites were randomly selected based on points identified on maps in Appendix 3, and a new set of sites was chosen for each spring and fall sample.

Experimental monofilament gill nets had dimensions of 45.7 x 1.8 m with six panels of varying mesh size (1.3 - 7.6 cm in 1.3 cm increments). Two nets were set at each randomly selected site; one on the surface and one on the bottom. Surface nets had additional foam floats attached to the float line to ensure that it remained at the surface. The two nets were separated by at least 100 m, each being set perpendicular to the shoreline with the smallest mesh towards the shore. All nets were set during early evening and retrieved approximately 12 hours later. Netted fish were removed and placed in a live well for processing.

Electrofishing

In November 2000 and May 2001, 16 randomly selected sites were sampled using nighttime boat electrofishing. The number of sites was increased to 24 in subsequent years to increase the accuracy of our estimates. During May 2003, only 20 sites were electrofished due to equipment failure.

Two different electrofishing boats were used during the study (due to equipment failure), however, the output (watts) remained constant throughout and we believe that differences in boat configuration did not bias our results. For all sampling trips, a 17 or 24 ft aluminum electrofishing boat was used, each equipped with an electric trolling motor. There were two spherical anodes suspended from retractable booms on the hull. From November 2001 through November 2002, the 24 ft boat was used and equipped with a Coffelt VVP-15 electrofishing unit and a 6000-watt generator. In all other samples, the 17 ft boat was used and equipped with a Smith-Root 5.0 GPP electrofishing unit and a 5000-watt generator.

The shoreline was electroshocked in a counter-clockwise direction beginning at the coordinates of each randomly selected site and continued for approximately 15 minutes (900 seconds). Randomly selected sites were never contiguous, so as to avoid overlapping samples. All fish netted were transferred to a live-well prior to processing.

Data Analysis

All captured fish were identified to species, measured (TL; ± 1 mm), weighed (± 1 g) and released. All sunfish and crappie species were combined as "sunfish" and "crappie" for composition and abundance measures, but each species was analyzed separately for size structure analyses.

Data that did not meet assumptions for parametric tests were normalized with transformations when possible. However, the parametric tests described for each segment of the objective are robust enough to overcome violations of the assumptions (Zar 1996), so nonparametric tests were not used. All statistical tests were considered significant at $P < 0.10$ (based on power and sample size considerations described above).

Species Composition

Due to species selectivity of each gear type, a single gear should not be used to assess fish community structure (Reynolds 1996). Percent species composition in Lake Pleasant was evaluated by combining electrofishing and gill netting data for each sampling trip. A chi-square test was used to determine if there were differences in species composition among years for each season. A Tukey-type multiple comparison was used to test differences among the arcsine transformed proportions when there was a significant chi-square (Zar 1996). A t-test was used to identify differences in mean percent species composition (arsine transformed) between phases for each season.

Relative Abundance

In Phase I, net night units (NNU; 12 hours) were used as the measure of effort for gill net sampling. To stay consistent with Arizona Game and Fish Department sampling protocol (Bryan 2004), all data was converted to 'hour' as the measure of effort. CPUE for gill netting was calculated as catch per hour using the mean of ratios method (described in Angler Survey methods):

$$CPUE = \frac{1}{n} \times \sum_{i=1}^{n} \left(\frac{C_i}{H_i} \right) \tag{10}$$

where C_i = catch in the ith net, H_i = length the ith net was fished (hours), and n = number of nets.

Electrofishing effort was defined as a 15-minute time period and CPUE for each transect was calculated as catch per 15 minutes:

$$CPUE = \frac{1}{n} \times \sum_{i=1}^{n} \left(\frac{C_i}{T_i} \right) \tag{11}$$

where C_i = catch in the ith electrofishing transect, T_i = number of 15 minute increments sampled in the ith transect, and n = number of transects.

Relative abundance (CPUE) of species susceptible to each gear type (Table 1) was compared among years and within the same season using ANOVA and Tukey's multiple comparison tests. Relative abundance between phases was compared using a t-test.

Table 1. Gear type to which species found in Lake Pleasant are most susceptible (based on previous data).

Gill Netting	Electrofishing
Yellow Bullhead	Common Carp
Crappie	Red Shiner
Common Carp	Threadfin Shad
Threadfin Shad	Mosquitofish
Channel Catfish	Largemouth Bass
White Bass	Crappie
Striped Bass	Sunfish
Flathead Catfish	
Golden Shiner	
Tilapia	

Size Structure

Mean length and weight of each species were compared among years (within a season) and between basins using ANOVA and Tukey's multiple comparison tests. A t-test was used to compare mean length and weight between phases. Length-frequency histograms were constructed for sportfish species to help identify problems such as year-class failure, low recruitment, slow growth, or excessive annual mortality (Anderson and Neumann 1996).

Size structure of individual species was further evaluated using Proportional Stock Density (PSD; Anderson 1978) and Relative Stock Density (RSD; Gablehouse 1984) of incremental size categories [stock-quality (S-Q), quality-preferred (Q-P), preferred-memorable (P-M), and memorable-trophy (M-T) plus trophy length fish (T)]:

$$\text{PSD} = \frac{\text{No. of fish} \geq \text{quality length}}{\text{No. of fish} \geq \text{stock length}} \times 100 \qquad (12)$$

and,

$$\text{RSD} = \frac{\text{No. of fish within size category}}{\text{No. of fish} \geq \text{stock length}} \times 100 \qquad (13)$$

Ranges for the five-cell length categories are based on world record lengths (Gablehouse 1984) and defined for each species by Willis et al. (1993). PSD values for each species were visually compared among years (within a season) to identify potential population trends. For comparisons between phases, PSD of each species was arcsine transformed and mean values were compared within a season using ANOVA and Tukey's multiple comparison test (Zar 1996). Confidence intervals developed by Gustafson (1988) were calculated for PSD of each species. RSD values were not compared among years or between phases; rather they were simply evaluated by incremental length category to identify strong or weak year-classes (Willis et al. 1993), or other bottlenecks in growth.

The relative weight index (W_r) was used to evaluate fish condition based on the equation developed by Wege and Anderson (1978):

$$W_r = \frac{\text{Weight of fish}}{W_s} \times 100 \qquad (14)$$

where W_s is the length-specific standard weight for individual species (as reported in Anderson and Neumann 1996, and Bister et al. 2000). ANOVA and Tukey's multiple comparison tests were used to compare mean W_r among years for each species within a season. T-tests were used to compare mean W_r between phases. Relative weight was also calculated for each incremental length category (see above). Evaluating W_r across length groups ensures that nuances associated with length-related condition do not go undetected (as tends to happen when only population W_r is examined; Murphy et al. 1991).

Age, Growth, Food Habits, and Fish Health

In addition to the primary objectives of the study, we examined age and growth, food habits, and general health of the primary predators during 2002-2003. Up to 10 white bass, largemouth bass, and striped bass from each 50 mm length group were sacrificed for otolith removal to determine age and growth. Otoliths of fish < 2 years were aged in whole view, while otoliths of fish > 2 years were sectioned, mounted, and examined under a microscope. All fish were aged by three independent readers. When possible, annuli were digitized and length at age was determined using FishBC software (Ball State University).

Stomachs were removed from up to 10 white bass and largemouth bass in each 50 mm length group in November 2002. In the lab, food items were identified to species when possible, enumerated, and weighed (wet weight).

Finally, tissue samples from 60 largemouth bass of various sizes (>250 mm) were obtained and transferred to the Pinetop Fish Health Lab to test for the presence of Largemouth Bass Virus (LMBV) and other bacterial and viral pathogens.

Water Quality

We collected temperature, dissolved oxygen (DO), pH, specific conductance, water clarity (secchi depth) and chlorophyll measurements each month (November 2000 – October 2003) at six stations along the original Aqua Fria River channel and two stations in coves (Figure 3). These stations approximated those used in Phase I (Morgensen 1990). A YSI 6920 Sonde and YSI 610 Display/Logger were used to measure water quality variables at 1-m depth intervals at each station. Light penetration was measured using a secchi disk and taking measurements from both the shaded side and the sunny side of the boat. For analyses, the mean secchi depth was used. Two 1 L water samples were collected at each station at the surface for chlorophyll-a analysis.

In addition, we used CAP Environmental Department quarterly water sample data collected at a single location near New Waddell Dam. Samples were taken from the surface and returned to a laboratory where they were tested for nutrients, metals, and contaminants. We used their data for evaluation of the water chemistry in Lake Pleasant.

Data Analysis

We used mean surface values to make comparisons among years in Phase II (ANOVA). For pre- and post-dam comparisons, we used t-tests to determine differences in mean surface values. We also examined changes in water quality at the level of the thermocline (when stratified) during each year of the study.

Mean chlorophyll and secchi measurements were compared among sites, basins, and years in Phase II using ANOVA. In addition, mean chlorophyll levels at the dam site and at the Agua Fria site were plotted against Agua Fria inflow and reservoir elevations to determine if there was a relationship between those variables and chlorophyll levels. Comparisons of mean values between phases were made using t-tests.

Nutrients, metals, and contaminants were evaluated to determine changes among years in Phase II (ANOVA). When possible, mean values measured by CAP in Phase II were compared to Phase I values using t-tests.

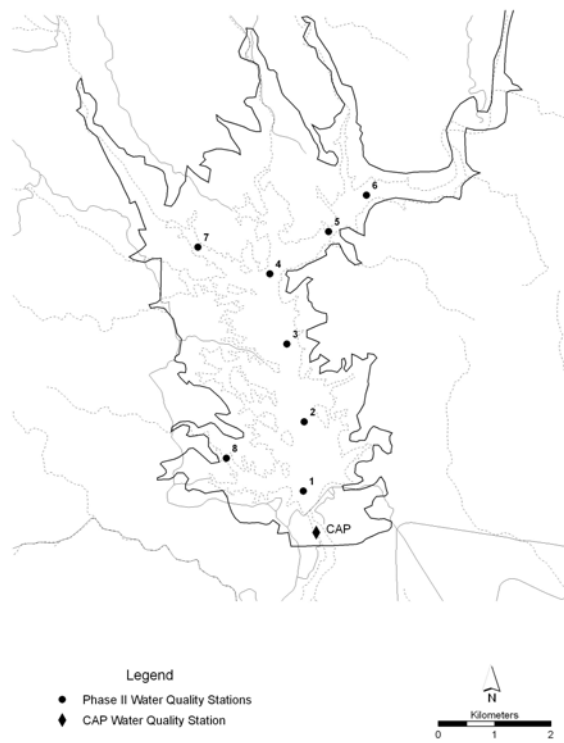

Figure 3. Map of Lake Pleasant with water quality sampling sites. Sites 1-6 are along the original Agua Fria River channel, sites 7-8 were cove sites in Phase I, and retained as sample sites in Phase II. CAP collected nutrient, metal, and contaminant samples from the site nearest New Waddell Dam.

RESULTS

Angler Surveys – Phase II

A total of 5,559 anglers were interviewed during Phase II. Exit interviews (complete trips) were obtained from 4,061 anglers, and roving interviews (incomplete trips) were obtained from 1,498 anglers. Of those interviewed, 84.8% were fishing from boats, while 15.2% were fishing from the shoreline. Most anglers interviewed were adults (88.9%), while only 11.1% of anglers were under the age of 15. It is interesting to note that the proportion of anglers under the age of 15 increased each year from 2001 (8.9%) through 2004 (13.0%).

Angler Preferences

The proportion of anglers fishing solely for largemouth bass decreased in each year of the study, from over 57% in 2001 to just fewer than 40% in 2004 (Figure 4). During that same time, the number of anglers fishing for "anything they could catch" or multiple species increased from 28% to over 42%. The percentage of anglers targeting white bass was relatively steady, while crappie and bluegill anglers increased over the course of the study. The number of striped bass anglers remained low throughout.

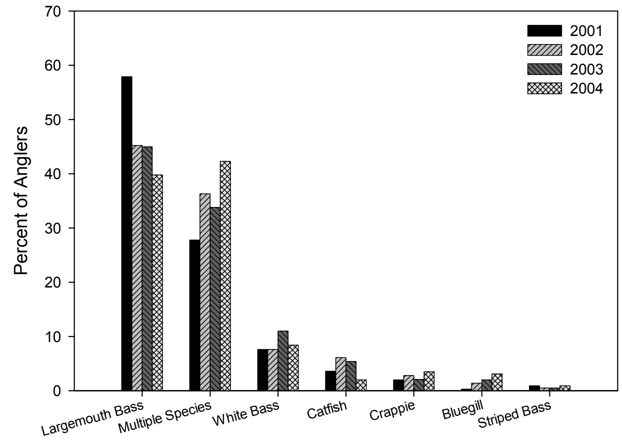

Figure 4. Percent of anglers targeting specific species at Lake Pleasant during 2001-2004.

Angling Pressure

Length of mean angler day varied by entry gate (Table 2). From 2001-2003, anglers launching from the Marina boat ramps fished longest. In 2004, anglers launching from Castle Creek fished longest. Throughout the study, anglers leaving from the ten-lane ramp had the shortest fishing day. The overall mean angler day varied among years, but was lower in 2002 (4:57, SE = 3:52) than any other year (ANOVA; $P < 0.001$).

In terms of total visitors, entry counts were similar among years, but slightly lower in 2003 than in other years and highest in 2004 (Table 2). The percentage of vehicles with anglers and the number of anglers per vehicle varied depending on the entry gate. The South Park entry (10-lane) experienced the heaviest traffic, but the percentage of vehicles with anglers was over 1.5 times more at the Castle Bay entry. Pleasant Harbor Marina was used most by non-angling boaters.

Whole lake estimates of angling pressure from access surveys decreased each year from a high of over 705,000 angler hours in 2001 to just over 394,000 in 2004 (Figure 5). Total angling pressure (including incomplete surveys) was similar during 2002-2004, but over 1.5 times lower than in 2001. Estimates of angler hours for each stratum for 2001-2004 are reported in Appendix 4.

Angler Catch and Harvest

Catch-per-unit-effort (CPUE) calculated as the total catch divided by total effort by all anglers (total ratio estimate), decreased by 21% from 2001-2004 (Table 3). However, this change cannot be statistically tested because there is no variance associated with the estimate. It is used for comparisons when similar calculations are available (see Table 6).

Table 2. Fishing pressure measured as number of anglers. Total number of vehicles was based on gate counts by the controlling authority; percent of vehicles with anglers and the number of anglers per vehicle were means of data collected in random gate count surveys in 2002 and 2004. Mean angler day (hours) was determined from completed trip interviews.

	No. Of Vehicles	% With Anglers	Anglers/Vehicle	Total Anglers	Mean Angler Day (SE)
2001					
South Park	165,899	28.4%	2.05	96,586	5:26 (0:08)
Castle Bay	23,700	45.1%	1.92	20,522	5:37 (0:05)
Marina	94,453	24.8%	1.75	40,993	5:43 (0:19)
Total	284,052			158,101	5:35 (0:04)
2002					
South Park	162,304	28.4%	2.05	94,494	4:43 (0:05)
Castle Bay	23,186	45.1%	1.92	20,078	5:05 (0:06)
Marina	94,689	24.8%	1.75	41,095	5:19 (0:13)
Total	280,180			155,666	4:57 (0:04)
2003					
South Park	158,220	28.4%	2.05	92,116	4:28 (0:09)
Castle Bay	22,603	45.1%	1.92	19,572	5:38 (0:07)
Marina	96,123	24.8%	1.75	41,717	5:57 (0:11)
Total	276,946			153,406	5:21 (0:05)
2004					
South Park	159,517	28.4%	2.05	92,871	4:36 (0:11)
Castle Bay	22,788	45.1%	1.92	19,733	5:42 (0:09)
Marina	103,150	24.8%	1.75	44,767	5:03 (0:10)
Total	285,455			157,371	5:19 (0:06)

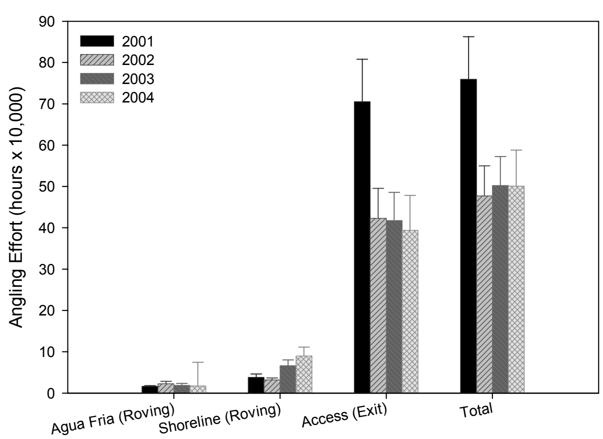

Figure 5. Estimated whole lake angling effort (with error bars) for roving and exit surveys at Lake Pleasant, 2001-2004.

For a more accurate estimate of catch rates, the mean of ratios estimate was calculated and used to make comparisons among years. Similar to the total ratio estimate, mean CPUE decreased in each year of the study (Figure 6), totaling a 25% decrease from 2001 (0.40 fish/h) to 2004 (0.30 fish/h) (ANOVA; $P = 0.036$).

Mean CPUE in spring 2001 was higher than in all other years (ANOVA; $P < 0.001$; Figure 6). Mean winter CPUE in 2002 was lower than in winter 2001 (ANOVA; $P = 0.004$). Mean summer CPUE did not differ significantly among years. Mean monthly CPUE did not follow a distinctive pattern throughout the study; it is presented in Appendix 6.

Table 3. Catch-per-unit-effort (CPUE) measured as a "total ratio estimate".

Year	Hours	Fish	CPUE
2001	8,681.75	3,308	0.38
2002	5,801.58	1,889	0.33
2003	6,635.50	2,281	0.34
2004	5,366.50	1,613	0.30

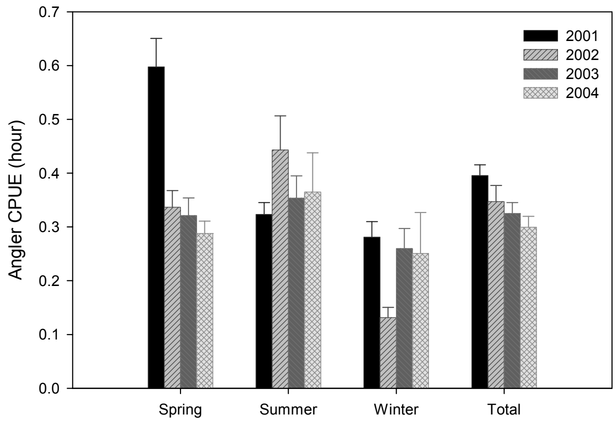

Figure 6. Mean seasonal angler CPUE in Lake Pleasant from 2001-2004. Bars represent standard error.

Mean catch rates of targeted species (i.e. CPUE of species when specifically targeted by an angler) differed among years for largemouth bass, white bass, and sunfish (Table 4). For largemouth bass, catch rates declined in each year of the study, with 2001 catch rates being significantly higher than all other years (ANOVA; $P < 0.001$). White bass catch rates were also highest in 2001, but only differed significantly from 2003 (ANOVA; $P = 0.032$). Sunfish catch rates were highest in 2003 (ANOVA; P = 0.001). Seasonal catch rates for targeted species are reported in Appendix 7.

The mean percentage of fishes caught that were harvested by anglers increased over the course of the study, from 30% in 2001 to over 38% in 2004 (Figure 7). Harvest of largemouth bass stayed constant over the four years at approximately 18%. Harvest of white bass, catfish, and crappie was always above 40%. Striped bass harvest was over 50% in all years except 2003. Sunfish harvest decreased steadily throughout the study.

Whole lake estimates of the number of fish caught and harvested declined dramatically in 2002 from the high in 2001, and then remained relatively steady in subsequent years (Table 5). The decline from 2001 was primarily seen in catch and harvest of largemouth bass and white bass. Catch of largemouth bass and white bass was higher than all other species during each year, while harvest of white bass was higher than all other species. Estimated catch and harvest of crappie declined substantially in 2003, but increased again in 2004. Striped bass estimated catch and harvest was highest in 2004, but relatively steady throughout the study. Catch and harvest of all other species fluctuated among years.

Angler Success

For completed trip interviews, an average of 47.9% (SE = 1.9) of anglers were successful in catching at least one fish throughout the course of the study. Success in 2001 was highest at 53.5% and lowest in 2003 (44.5%). The 9% decrease in success was a statistically significant decline (chi-square; $P < 0.001$), but success increased again in 2004 by over 3%. Success of shore anglers in catching at least one fish ranged from a high of 39% in 2001 to just 20% in subsequent years. Success of boat anglers ranged from 45-54%.

Table 4. Mean CPUE (SE in parentheses) of species caught by anglers targeting that species during 2001-2004 in Lake Pleasant. Superscript letters indicate statistically significant differences among years (ANOVA; $P < 0.05$).

Species	2001	2002	2003	2004
Largemouth Bass	0.33 (0.02)^{a}	0.24 (0.02)^{b}	0.23 (0.02)^{b}	0.22 (0.02)^{b}
White Bass	0.96 (0.12)^{a}	0.72 (0.14)^{ab}	0.43 (0.11)^{b}	0.67 (0.12)^{ab}
Striped Bass	0.10 (0.05)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Catfish	0.18 (0.05)	0.11 (0.03)	0.06 (0.02)	0.04 (0.02)
Sunfish	0.13 (0.08)^{a}	0.61 (0.28)^{ab}	2.03 (0.47)^{b}	0.07 (0.05)^{a}
Crappie	0.14 (0.10)	0.11 (0.05)	0.00 (0.00)	0.11 (0.05)
Multiple Species	0.24 (0.03)	0.34 (0.08)	0.23 (0.03)	0.24 (0.04)

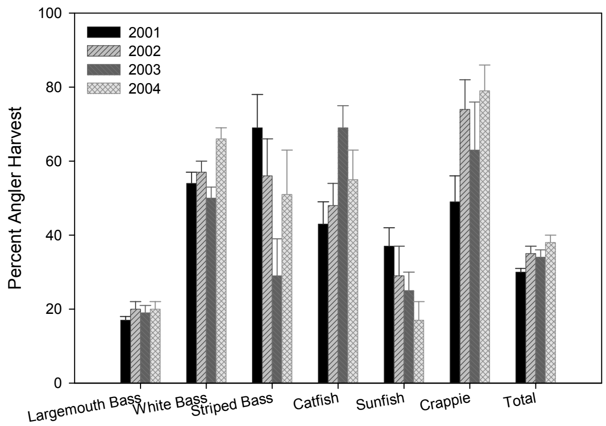

Figure 7. Mean percent angler harvest (with error bars) in Lake Pleasant from 2001-2004.

A second measure of success, anglers that caught at least one fish that was targeted, revealed that at least 40% of anglers fishing for largemouth bass and white bass were successful during each year (Figure 8). The few anglers that targeted striped bass at Lake Pleasant (*n* ranged from 5-15 per year) were largely unsuccessful. Those anglers who were fishing for "anything they could catch" or multiple species were consistently successful approximately 35% of the time.

Angler Satisfaction

At the time of interview, anglers were asked to rate their degree of satisfaction with their fishing trip in categories of poor, fair, good, and excellent. Throughout Phase II, approximately half of the anglers interviewed rated their fishing experience as poor. Over 25% rated it fair, 17% good, and 3-4% rated their satisfaction as excellent (Figure 9). The mean satisfaction rating was higher in 2004 (1.78) than in 2003 (1.69)(ANOVA; P = 0.032), but did not differ among other years. Not surprisingly, angler satisfaction increased as catch rates increased (Figure 10).

Table 5. Estimated total catch and harvest (SE in parentheses) by anglers fishing Lake Pleasant during 2001-2004. Individual seasonal totals for access, shoreline, and roving surveys are reported in Appendix 5a-5h.

Catch	2001	2002	2003	2004
Largemouth Bass	183,442 (29,523)	66,012 (9,384)	72,141 (9,877)	62,112 (10,089)
White Bass	128,497 (32,526)	46,991(6,793)	68,092 (9,539)	62,643 (12,244)
Striped Bass	2,469 (414)	3,092 (830)	2,268 (397)	5,419 (1,099)
Catfish	6,994 (1,134)	10,136 (1,732)	7,572 (1,258)	4,509 (785)
Common Carp	558 (173)	36 (25)	418 (200)	471 (168)
Crappie	9,034 (1,591)	10,360 (3,024)	1,615 (269)	13,091 (2,410)
Sunfish	14,840 (2,875)	8,662 (1,681)	24,918 (4,630)	12,078 (3,168)
Totals	345,834 (63,017)	145,288 (20,131)	177,024 (22,030)	160,323 (25,185)
Harvest	2001	2002	2003	2004
Largemouth Bass	18,853 (2,737)	10,591 (2,251)	14,566 (2,373)	10,944 (1,903)
White Bass	84,978 (23,186)	31,214 (5,129)	32,075 (5,313)	26,110 (4,412)
Striped Bass	1,796 (311)	1,026 (414)	579 (149)	2,822 (562)
Catfish	3,418 (592)	3,152 (363)	4,639 (630)	2,239 (563)
Common Carp	152 (76)	0 (0)	32 (16)	17 (12)
Crappie	6,405 (1,292)	6,602 (2,771)	1,061 (183)	10,805 (2,274)
Sunfish	1,796 (311)	466 (76)	7,676 (1,671)	700 (129)
Totals	119,702 (26,523)	53,051 (10,119)	60,627 (8,564)	53,689 (8,064)

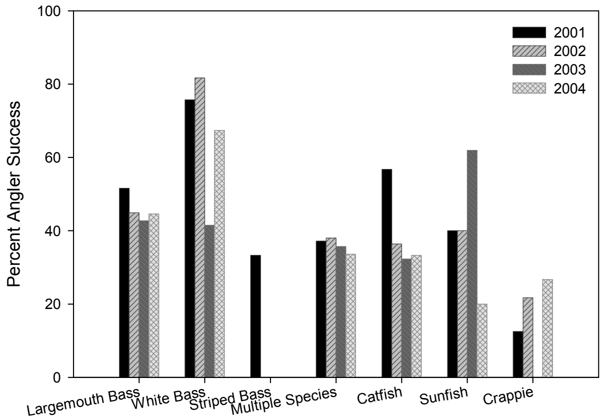

Figure 8. Percent angler success at Lake Pleasant, 2001-2004. Success was measured as the proportion of anglers that caught at least one fish that was targeted.

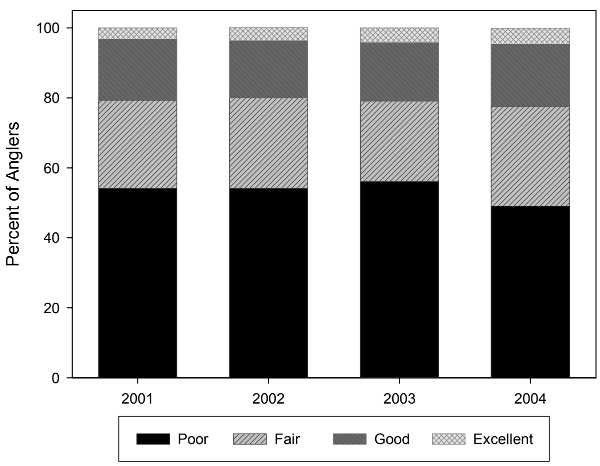

Figure 9. Percent satisfaction of anglers fishing in Lake Pleasant during 2001-2004.

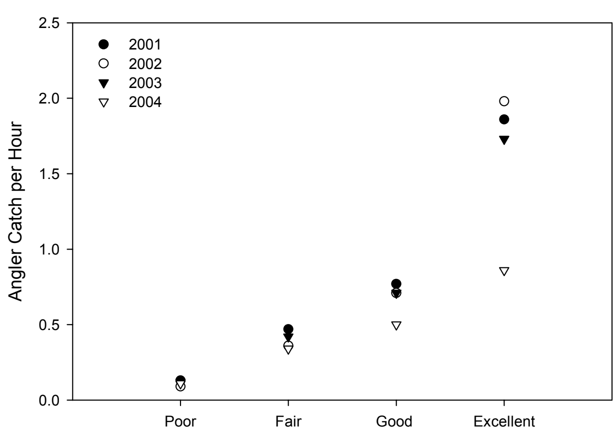

Figure 10. Mean CPUE (fish/hour) by angler satisfaction level. Error bars have been omitted for ease of reading.

Angler Surveys – Phase Comparison

Nearly 19,000 anglers were interviewed during Phase I, which is over three times as many anglers as were interviewed in Phase II. For both phases, few anglers were under the age of 15 (13.8% in Phase I, 11.1% in Phase II). In addition, the percentage of shore anglers decreased significantly between the two phases (Figure 11; chi-square; $P < 0.001$).

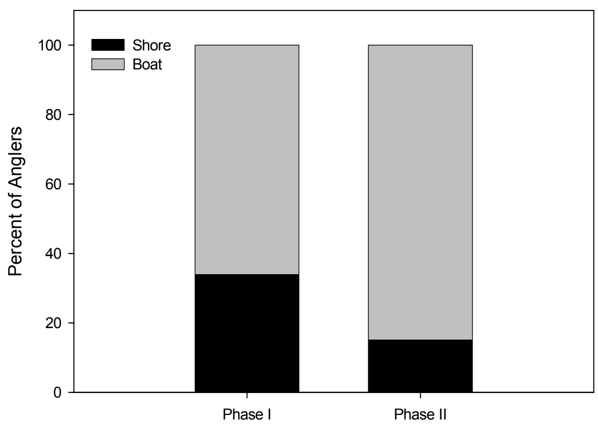

Figure 11. Percent of anglers fishing from shore and from a boat during Phase I and Phase II.

Angler Preferences

Angler preference for largemouth bass and multiple species reversed between the two phases (Figure 12). The proportion of anglers fishing solely for largemouth bass and white bass both increased in Phase II, while the proportion of anglers fishing for multiple species (or "anything"), catfish, and bluegill decreased (chi-square; $P < 0.001$). The proportion of crappie anglers was consistent between the two phases.

Angling Pressure

Mean length of angler day increased by nearly 40 minutes from Phase I (4:42; SE = 0:01) to Phase II (5:20; SE = 0:02) (t-test; $P < 0.001$).

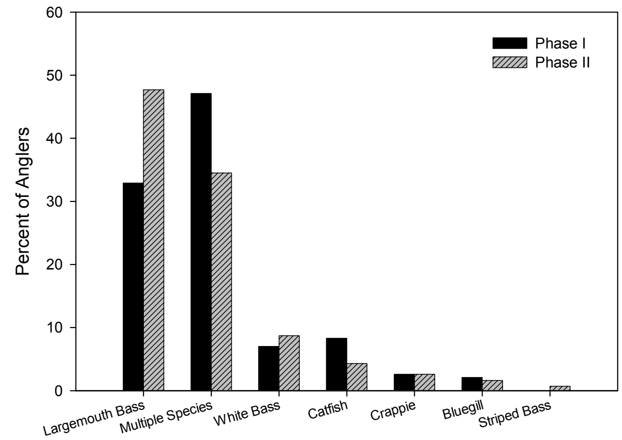

Figure 12. Percent of anglers targeting specific species at Lake Pleasant during Phase I and Phase II.

Based on data supplied by Maricopa County Parks and Maricopa Water Division (unpublished reports), the estimated number of park visitors averaged 899,949 (SE = 38,744) in Phase I, and 844,975 (SE = 5,779) during Phase II, and were not significantly different (t-test, $\alpha = 0.05$). The estimated mean yearly number of anglers significantly decreased 62.5% from 416,677 (SE = 17,939) anglers in Phase I to 156,336 (SE = 1,043) anglers in Phase II (t-test; $P < 0.001$).

Whole lake estimates of angling pressure were calculated for each phase from exit interviews only. Roving surveys were excluded because count data from Phase I were not available. In Phase I, mean estimated effort was 457,759 angler hours. Phase II mean estimated effort increased by nearly 6% to 484,977 angler hours. Seasonal estimates of pressure for Phase I and II are reported in appendix 8 and Appendix 4, respectively.

Angler Catch and Harvest

The total ratio estimate of CPUE for Phase I was 0.39 fish/h and in Phase II it was 0.34 fish/h, which represents a 13% decrease from Phase I to Phase II. Although creel surveys were not conducted on any other central Arizona warm-water reservoirs in the past 15 years, these estimates are comparable to past surveys (Table 6).

Table 6. Angler catch rates (total ratio estimate) from central Arizona reservoirs as measured by creel surveys. Values previous to 2001 were taken from Morgensen et al. (1990).

Lake	Period	Days Surveyed	Fish/hr.
Pleasant	01/01-12/04	322	0.34
Pleasant	09/87-09/89	238	0.39
Pleasant	1985	56	0.30
Pleasant	1984	36	0.30
Roosevelt	09/88-08/89	87	0.39
Roosevelt	1985	58	0.39
Apache	1985	46	0.37
Canyon	1985	49	0.24
Canyon	1984	42	0.38
Saguaro	1985	26	0.41

A mean of ratios calculation to determine angler CPUE was used to make comparisons between Phases. In Phase I, mean CPUE (all species) was 0.43 fish/h (SE = 0.01) compared to 0.35 fish/h (SE = 0.01) in Phase II (t-test; $P < 0.001$). This represents an 18.3% decrease in mean angler CPUE from Phase I to Phase II. Shore anglers had a mean catch rate of 0.49 (SE = 0.02) in Phase I, and just 0.22 (SE = 0.04) in Phase II (t-test; $P < 0.001$). Mean catch rates for boat anglers in Phase I was 0.42 (SE = 0.01) and 0.36 (SE = 0.01) in Phase II (t-test; $P = 0.01$).

Seasonally, mean angler CPUE was not significantly different during spring between the two phases (Figure 12). However, mean CPUE in summer was higher in Phase I than in Phase II (t-test; $P < 0.001$), and CPUE in winter of Phase II was higher than in Phase I (t-test; $P < 0.001$). Mean monthly CPUE followed a similar pattern (Appendix 9).

Mean catch rates of targeted largemouth bass and white bass were higher in Phase II than in Phase I (t-test; P < 0.004)(Figure 13). The opposite was true for all other species, but only differences in mean CPUE of targeted sunfish and multiple species were significant (t-test; P < 0.009). Seasonal catch rates of targeted species are reported in Appendix 10.

The mean percentage of fish that were

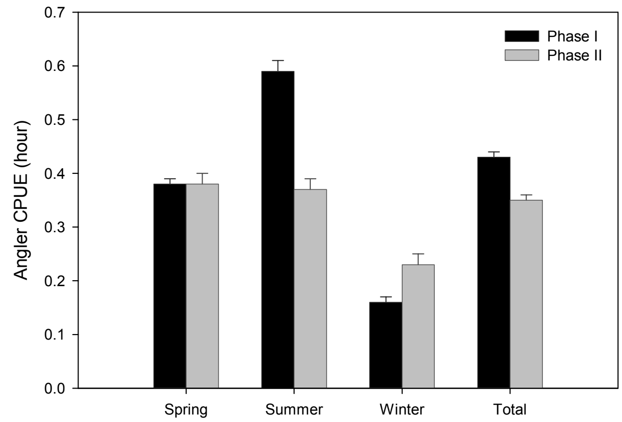

Figure 12. Mean seasonal angler CPUE in Lake Pleasant during Phase I and Phase II. Bars represent standard error.

harvested decreased significantly from Phase I (43%) to Phase II (34%)(t-test; $P < 0.001$) (Figure 14). For individual species, harvest of largemouth bass was 45% in Phase I, compared to only 18% in Phase II (t-test; P <0.001). Harvest of white bass also declined from 77% in Phase I to 56% in Phase II (t-test; $P < 0.001$). Only percent harvest of sunfish was higher in Phase II (t-test; $P = 0.04$).

Whole lake estimates of the number of fish caught and harvested (from exit interviews only) indicates that nearly twice as many largemouth bass were caught annually in Phase II than in Phase I (Table 7). However, more largemouth bass were harvested in Phase I. Additionally, over 2.5 times as many white bass were caught in Phase II. Catch and harvest of sunfish decreased by over 86% from Phase I to Phase II. Overall, though, catch and harvest estimates were very similar in both phases. Seasonal totals for access surveys are reported in Appendices 5 (Phase II) and 11 (Phase I).

Angler Success

Angler success in catching at least one fish did not differ between phases (chi-square; P =

0.256). In Phase I, success was 47.9%, while in Phase II angler success was 48.9%. Seasonally, success was higher in Phase I during

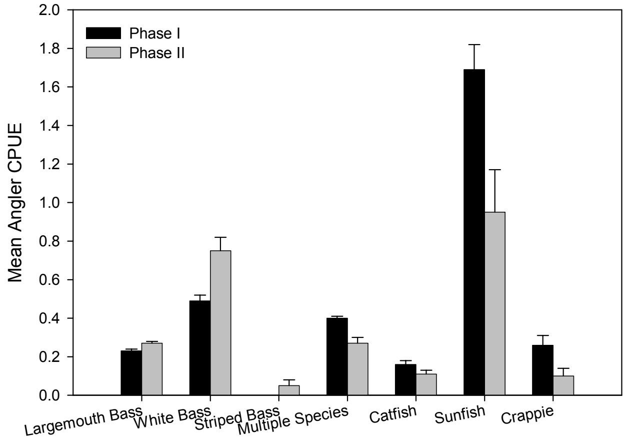

Figure 13. Mean angler CPUE for targeted species in Lake Pleasant during Phase I and Phase II. Bars represent standard error.

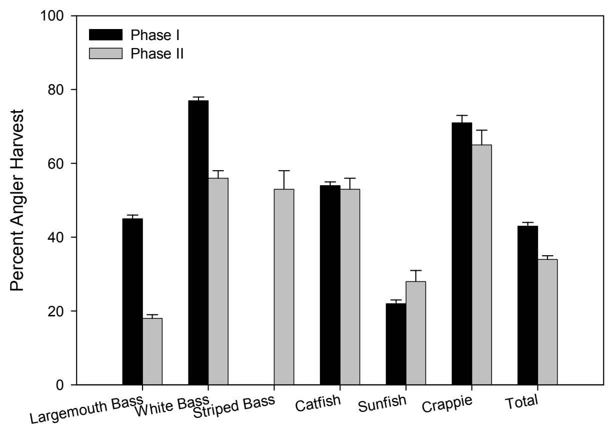

Figure 14. Mean percent angler harvest (with error bars) in Lake Pleasant during Phase I and Phase II.

summer (chi-square; $P < 0.001$), and higher in Phase II during spring (chi-square, $P < 0.001$) and winter (chi-square; $P < 0.001$). Shore anglers were more successful during Phase I (42.0%) compared to Phase II (23.7%)(chi-square; $P < 0.001$). Success of boat anglers was 49% in both phases.

Success for anglers catching at least one fish that was targeted was higher in Phase II than in Phase I for largemouth bass, white bass, and catfish anglers (chi-square; $P < 0.01$)(Figure 15). For anglers targeting sunfish, crappie, and multiple species, a higher proportion of success was achieved during Phase I (chi-square; P < 0.003).

Table 7. Estimated annual total catch and harvest by anglers fishing Lake Pleasant during Phase I and Phase II.

Catch	Phase I	Phase II
Yellow Bullhead	98	0
Common Carp	1,170	188
Largemouth Bass	46,307	89,550
White Bass	26,826	67,896
Striped Bass	0	3,055
Catfish	14,830	5,290
Crappie	6,190	7,628
Sunfish	78,670	10,729
Totals	174,092	184,337

Harvest	Phase I	Phase II
Yellow Bullhead	30	0
Common Carp	493	0
Largemouth Bass	15,744	11,805
White Bass	21,599	38,554
Striped Bass	0	1,371
Catfish	7,499	2,447
Crappie	4,326	5,366
Sunfish	16,522	2,130
Totals	66,185	61,674

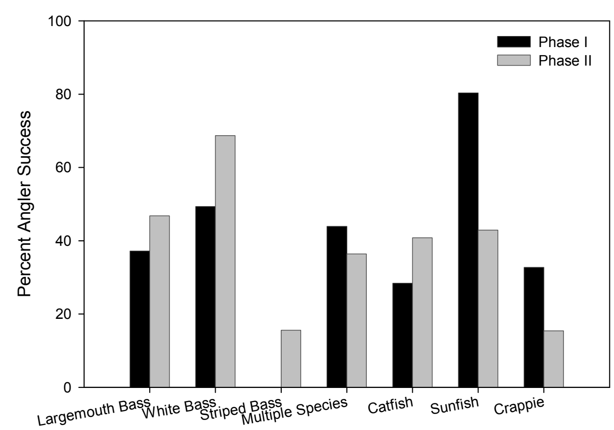

Figure 15. Percent angler success at Lake Pleasant during Phase I and Phase II. Success was measured as the proportion of anglers that caught at least one fish that was targeted.

Angler Satisfaction

Over 60% of anglers rated their fishing experience as poor in Phase I, while significantly fewer anglers (53.6%) gave a poor rating in Phase II (chi-square; $P < 0.001$)(Figure 16). The mean satisfaction rating in Phase I was 1.58 (SE = 0.01), compared to 1.71 (SE = 0.01) in Phase II. For both phases, satisfaction increased as mean angler CPUE increased (Figure 17).

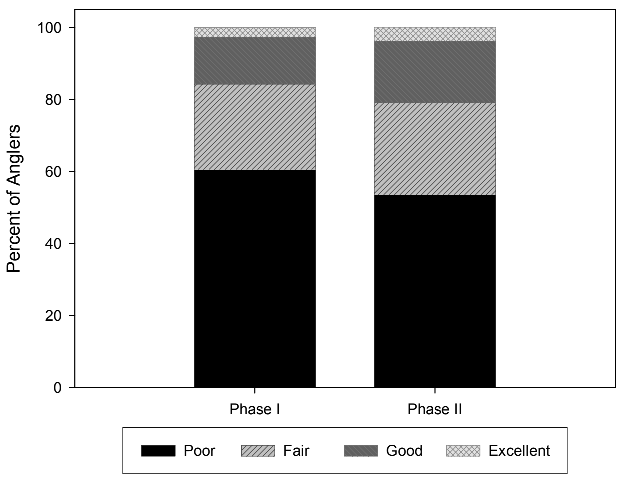

Figure 16. Percent satisfaction of anglers fishing in Lake Pleasant during Phase I and Phase II.

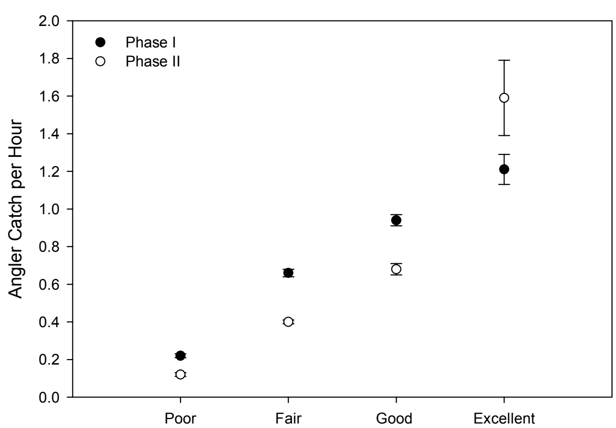

Figure 17. Mean CPUE (fish/hour), with standard error bars, by angler satisfaction level.

Summary

A brief summary of angler survey phase comparison parameters is presented in Table 8. Virtually all comparisons between phases were statistically significant (as just described), in part due to the large sample sizes available for comparisons.

Table 8. Summary of angler survey phase comparison parameters. Where appropriate, SE is shown in parentheses.

Parameter	Phase I	Phase II
Angler Effort	4:42 (0:01)	5:20 (0:02)
Angler Success	47.9%	48.9%
Angler Preferences		
Largemouth Bass	32.9%	47.7%
Multiple Species	47.1%	34.5%
White Bass	7.0%	8.7%
Catfish	8.3%	4.3%
Crappie	2.6%	2.6%
Bluegill	2.1%	1.6%
Striped Bass	--	0.7%
Overall Catch Rate (Mean of Ratios)	0.43 fish/hr (0.01)	0.35 fish/hr (0.01)
Catch Rate From Shore	0.49 fish/hr (0.02)	0.22 fish/hr (0.04)
Catch Rate From Boat	0.42 fish/hr (0.01)	0.36 fish/hr (0.01)
Specific Catch Rates		
Largemouth Bass	0.23 fish/hr (0.01)	0.27 fish/hr (0.01)
Multiple Species	0.40 fish/hr (0.01)	0.27 fish/hr (0.03)
White Bass	0.49 fish/hr (0.03)	0.75 fish/hr (0.07)
Catfish	0.16 fish/hr (0.02)	0.11 fish/hr (0.02)
Crappie	0.26 fish/hr (0.05)	0.10 fish/hr (0.04)
Bluegill	1.69 fish/hr (0.13)	0.95 fish/hr (0.22)
Striped Bass	--	0.05 fish/hr (0.03)
Success Rate for Anglers Targeting a Specific Species		
Largemouth Bass	37.2%	46.8%
Multiple Species	43.9%	36.4%
White Bass	49.3%	68.7%
Catfish	28.4%	40.8%
Crappie	32.7%	15.4%
Sunfish	80.3%	40.9%
Striped Bass	--	15.6%
Angler Satisfaction		
Excellent	2.6%	3.8%
Good	13.1%	17.2%
Fair	23.7%	25.5%
Poor	60.6%	53.6%

Population Dynamics – Phase II

Species Composition

During Phase II, sixteen species were collected from Lake Pleasant, including hybrid sunfish (Appendix 12). Percent composition was significantly different among years (within each season; chi-square, $P < 0.001$), primarily due to fluctuations in the catch of threadfin shad (Figure 18). Results of multiple comparison tests indicated that the percent composition of white bass and channel catfish in the overall catch decreased in both spring and fall from 2000-2004 (chi-square; $P < 0.10$). Threadfin shad fluctuated in fall, but increased significantly during spring (chi-square; $P < 0.10$) over the course of the study. Striped bass composition remained relatively constant, and largemouth bass and sunfish fluctuated seasonally.

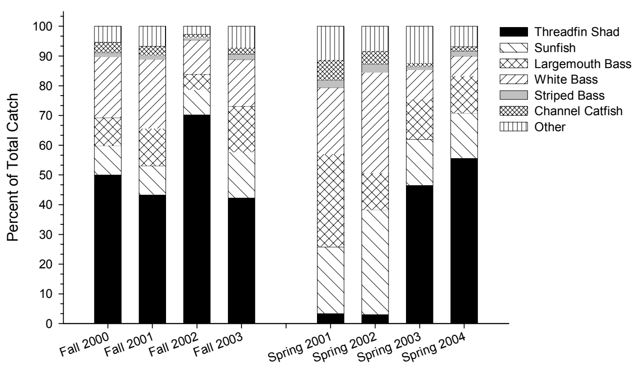

Figure 18. Seasonal percent composition of primary species caught in Lake Pleasant during Phase II. The "Other" category includes crappie, common carp, red shiner, golden shiner, flathead catfish, and tilapia.

Relative Abundance

Relative abundance (CPUE) of species susceptible to gill netting is reported in Table 9. During fall, overall mean CPUE was highest in 2002 (ANOVA; $P < 0.001$), primarily due to the high CPUE of threadfin shad. Highest catch rates for most other species occurred during 2003 (ANOVA; $P < 0.10$). White bass, channel catfish, and golden shiner abundance did not differ among years.

During spring, gill netting overall mean catch rates did not differ statistically (Table 9). For individual species, white bass catch rates were lower in 2004 than any other year (ANOVA; $P < 0.001$). Channel catfish CPUE was lowest in 2003 and 2004 (ANOVA; $P < 0.001$). Catch rates of all other species did not differ during spring.

Gill net mean CPUE only differed by basin in Fall 2002, Spring 2003, and Spring 2004 (ANOVA; $P < 0.10$); in each case, catch rates were higher in the upper basin. Individual species were only caught in higher numbers in the upper basin sporadically (ANOVA; $P < 0.10$). Striped bass were more abundant in the lower basin in Fall 2000 (ANOVA; $P = 0.09$)

Relative abundance of species susceptible to electrofishing is also reported in Table 9. During fall, overall catch rates were highest in 2002 (ANOVA; $P < 0.001$), again primarily due to the high CPUE of threadfin shad. The highest catch rates for largemouth bass and sunfish occurred in 2003 (ANOVA; $P < 0.10$). Crappie abundance did not differ among years, however the highest catch rates also occurred during 2003.

In spring, the highest catch rates occurred in 2003 (Table 9). Common carp, largemouth bass, and sunfish catch rates were highest in 2003 (ANOVA; $P < 0.01$). Threadfin shad and crappie CPUE did not differ statistically among years.

Electrofishing mean CPUE differed between basins only in Fall 2003; overall CPUE was higher in the upper basin (ANOVA; $P = 0.001$). Sunfish were more abundant in the upper basin in Fall 2001 and 2003 (ANOVA; $P < 0.10$), and threadfin shad were more abundant in the upper basin in Fall 2003 (ANOVA; $P = 0.024$).

Size Structure

Length-frequency histograms of species found in sufficient numbers are presented in

Table 9. Mean effort per net set (hour) or electrofishing site (15 minute unit), and CPUE (fish/hour for gill nets, fish/15 min for electrofishing) of fish species collected during fall and spring in Lake Pleasant 2000-2004. Standard error is in parentheses. Superscript letters indicate values that are statistically different (ANOVA, $P < 0.10$).

	Fall			
Gill Netting	2000	2001	2002	2003
Effort (hour)	*16.230 (0.362)*	*16.588 (0.192)*	*16.053 (0.293)*	*16.733 (0.155)*
Crappie	0.010 (0.015)^{a}	0.032 (0.012)^{a}	0.010 (0.012)^{a}	0.074 (0.012)^{b}
Common Carp	0.101 (0.026)^{ab}	0.040 (0.020)^{a}	0.093 (0.021)^{ab}	0.119 (0.020)^{b}
Threadfin Shad	0.714 (0.561)^{a}	0.904 (0.440)^{a}	3.587 (0.446)^{b}	1.809 (0.440)^{a}
Channel Catfish	0.086 (0.018)	0.071 (0.014)	0.086 (0.014)	0.119 (0.014)
White Bass	0.544 (0.169)	0.718 (0.133)	0.875 (0.134)	0.893 (0.133)
Striped Bass	0.040 (0.018)^{a}	0.039 (0.014)^{a}	0.060 (0.014)^{ab}	0.104 (0.014)^{b}
Flathead Catfish	0.003 (0.009)^{a}	0.002 (0.007)^{a}	0.012 (0.007)^{ab}	0.033 (0.007)^{b}
Golden Shiner	0.000 (0.004)	0.002 (0.003)	0.003 (0.003)	0.009 (0.003)
Tilapia	0.001 (0.010)^{a}	0.005 (0.008)^{ab}	0.001 (0.008)^{a}	0.029 (0.008)^{b}
Total Gill Net	*1.497 (0.626)^{a}*	*1.812 (0.491)^{a}*	*4.727 (0.497)^{b}*	*3.189 (0.491)^{ab}*
Electrofishing				
Effort (15 min)	*1.010 (0.005)*	*0.999 (0.011)*	*1.032 (0.008)*	*1.011 (0.021)*
Common Carp	0.432 (0.682)^{a}	3.349 (0.557)^{b}	1.802 (0.557)^{ab}	2.339 (0.557)^{ab}
Red Shiner	0.186 (0.057)^{a}	0.000 (0.000)^{b}	0.000 (0.000)^{b}	0.000 (0.000)^{b}
Threadfin Shad	14.548 (8.663)^{a}	12.045 (7.073)^{a}	47.258 (7.073)^{b}	17.114 (7.073)^{a}
Largemouth Bass	3.263 (1.814)^{a}	9.733 (1.481)^{b}	8.854 (1.481)^{b}	20.655 (1.481)^{c}
Crappie	0.000 (0.000)	0.041 (0.126)	0.083 (0.126)	0.435 (0.126)
Sunfish	6.155 (4.069)^{a}	6.933 (3.323)^{a}	15.300 (3.323)^{ab}	22.745 (3.323)^{b}
Total Electrofishing	*24.584 (11.402)^{a}*	*32.102 (9.310)^{ab}*	*73.296 (9.310)^{c}*	*63.288 (9.310)^{bc}*

	Spring			
Gill Netting	2001	2002	2003	2004
Effort (hour)	*13.904 (0.159)^{a}*	*14.777 (0.114)^{b}*	*14.907 (0.263)^{b}*	*16.265 (0.189)^{c}*
Crappie	0.017 (0.006)	0.002 (0.005)	0.013 (0.005)	0.006 (0.005)
Common Carp	0.164 (0.040)	0.112 (0.035)	0.220 (0.035)	0.132 (0.035)
Threadfin Shad	0.075 (0.821)	0.039 (0.711)	2.073 (0.711)	1.835 (0.720)
Channel Catfish	0.142 (0.017)^{a}	0.095 (0.015)^{a}	0.043 (0.015)^{b}	0.044 (0.015)^{b}
White Bass	0.489 (0.090)^{a}	0.738 (0.078)^{a}	0.499 (0.078)^{a}	0.209 (0.079)^{b}
Striped Bass	0.056 (0.020)	0.061 (0.017)	0.059 (0.017)	0.053 (0.017)
Flathead Catfish	0.012 (0.005)	0.007 (0.004)	0.007 (0.004)	0.008 (0.004)
Golden Shiner	0.000 (0.000)	0.000 (0.000)	0.007 (0.003)	0.000 (0.000)
Tilapia	0.005 (0.005)	0.000 (0.000)	0.007 (0.004)	0.000 (0.000)
Total Gill Net	*0.959 (0.842)*	*1.053 (0.729)*	*2.927 (0.729)*	*2.287 (0.739)*
Electrofishing				
Effort (15 min)	*1.117 (0.026)^{a}*	*1.013 (0.017)^{b}*	*1.007 (0.003)^{b}*	*1.029 (0.009)^{b}*
Common Carp	1.086 (1.724)^{a}	1.458 (1.407)^{a}	11.297 (1.542)^{b}	2.273 (1.407)^{a}
Threadfin Shad	0.001 (1.128)	0.701 (0.921)	3.098 (1.009)	0.246 (0.921)
Largemouth Bass	10.207 (1.814)^{a}	5.025 (1.481)^{a}	18.567 (1.622)^{b}	8.934 (1.481)^{a}
Crappie	0.105 (0.041)	0.001 (0.034)	0.050 (0.037)	0.001 (0.034)
Sunfish	10.042 (3.776)^{a}	17.204 (3.083)^{ab}	23.202 (3.377)^{b}	11.679 (3.083)^{a}
Total Electrofishing	*21.440 (4.985)^{a}*	*24.388 (4.070)^{a}*	*56.213 (4.459)^{b}*	*23.134 (4.070)^{a}*

Appendices 13a-13g. Mean total length (mm) and weight (g) varied among years (within each season) for most fish species (Tables 10-11). In fall, the primary predators (largemouth bass, white bass, striped bass, and black crappie) experienced their lowest mean lengths and weights during 2003. For those same species (except striped bass), their largest sizes were observed during the previous fall. During spring, largemouth bass and striped bass mean length was lowest during 2004 and highest during 2003. White bass were largest in spring 2002. Mean lengths and weights of sunfish species and threadfin shad varied considerably over the course of the study.

Mean total length also varied by basin within each season for many species (t-test; $P < 0.10$; Figure 19). Common carp were larger in the lower basin throughout the year and largemouth bass were larger in the upper basin. During fall, channel catfish and threadfin shad were larger in the lower basin. During spring, green sunfish were larger in the upper basin, and bluegill, white bass, and striped bass were larger in the lower basin.

Proportional stock density (PSD) of the primary sportfish species in Lake Pleasant was evaluated during each season (Table 12). There were very few trends in the four years of data collection, as most species had PSD values that fluctuated substantially. In fall, common carp, channel catfish, and white bass PSD was highest in 2001. Bluegill PSD was highest in 2002 but then decreased in 2003. Largemouth bass and white bass PSD was lowest in 2003, while striped bass PSD was highest in 2003. In spring, PSD of largemouth bass and striped bass were lowest in 2004, while white bass was at 100 in both 2002 and 2004. PSD of many of the sunfish species declined in 2004.

An evaluation of relative stock density (RSD) by incremental length category (Appendix 14) gives an indication of how size structure changes over time. Channel catfish and striped bass size structure is skewed towards smaller fish, as individuals rarely grow

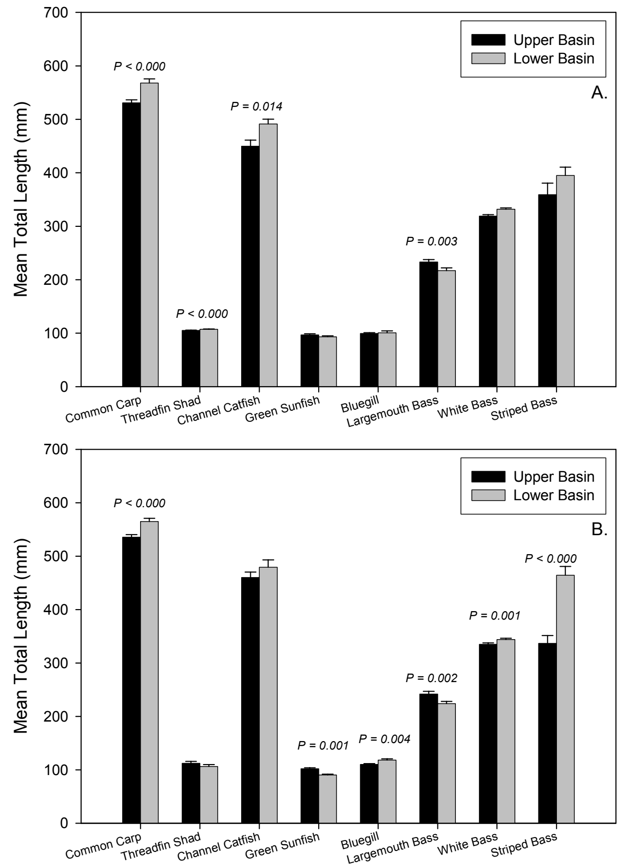

Figure 19. Mean total length (mm) of species caught with gill nets and electrofishing in the upper and lower basins of Lake Pleasant during Fall (A) and Spring (B), 2000-2004. *P*-values are provided where there is a significant difference in mean length of a species between basins (ANOVA, $P < 0.10$).

out of the quality-preferred category. Similarly, smaller individuals dominate green sunfish and bluegill populations, but they rarely grow out of the stock-quality range. Largemouth bass generally have a balanced population throughout the study, but it moves towards a population dominated by smaller individuals in 2003-2004. White bass and common carp populations consist primarily of larger individuals, as RSD values in the preferred-memorable category are typically larger than all other categories.

Relative weight (W_r) of the primary sportfish species in Lake Pleasant was calculated for each season (Table 13). Fall W_r was generally lowest

Table 10. Mean total length (mm) and weight (g), and number of each species measured from fall gill netting and electrofishing samples in Lake Pleasant 2000-2003. Standard error is in parentheses. Superscript letters indicate mean lengths or weights that differ (ANOVA; $P < 0.10$) among years for a given species.

		2000		2001		2002		2003	
		N	Mean (SE)	N	Mean (SE)	N	Mean (SE)	N	Mean (SE)
Common Carp	Length	48	541 (18)^{a}	106	573 (7)^{b}	102	538 (10)^{a}	134	535 (7)^{a}
	Weight	46	2171 (134)^{a}	106	2694 (83)^{b}	102	2247 (94)^{a}	134	2059 (69)^{a}
Red Shiner	Length	3	56 (6)	-	----	-	----	-	----
	Weight	-	----	-	----	-	----	-	----
Threadfin Shad	Length	387	97 (1)^{a}	582	109 (1)^{b}	296	113 (2)^{c}	641	106 (1)^{d}
	Weight	141	9 (1)^{a}	150	19 (1)^{b}	152	13 (1)^{c}	323	14 (1)^{c}
Channel Catfish	Length	36	492 (14)	60	484 (11)	55	478 (16)	76	444 (15)
	Weight	36	1339 (108)	60	1241 (90)	55	1181 (100)	75	1067 (100)
Green Sunfish	Length	5	116 (11)^{a}	46	99 (3)^{b}	193	89 (2)^{ab}	99	104 (3)^{ab}
	Weight	5	30 (9)^{a}	36	21 (3)^{ab}	191	13 (1)^{b}	99	23 (2)^{ab}
Bluegill	Length	75	87 (3)^{a}	136	100 (3)^{b}	152	110 (2)^{c}	356	98 (2)^{b}
	Weight	62	18 (3)^{a}	124	25 (3)^{ab}	150	28 (2)^{b}	329	22 (1)^{ab}
Redear Sunfish	Length	-	----	4	285 (9)^{a}	31	213 (11)^{b}	20	172 (14)^{b}
	Weight	-	----	4	445 (41)^{a}	31	219 (34)^{b}	20	124 (35)^{b}
Sunfish Hybrid	Length	2	177 (2)^{a}	6	87 (3)^{b}	8	128 (15)^{ab}	11	130 (15)^{ab}
	Weight	2	101 (8)	3	13 (3)	8	53 (22)	11	53 (16)
Largemouth Bass	Length	97	272 (11)^{a}	250	281 (6)^{a}	244	228 (7)^{b}	578	194 (5)^{c}
	Weight	95	398 (43)^{a}	249	402 (26)^{a}	242	273 (22)^{b}	572	211 (16)^{b}
White Bass	Length	206	337 (5)^{a}	453	346 (2)^{a}	530	336 (3)^{a}	583	293 (4)^{b}
	Weight	206	551 (18)^{a}	453	580 (10)^{a}	529	537 (10)^{a}	583	413 (14)^{b}
Striped Bass	Length	14	455 (37)^{a}	27	414 (33)^{a}	36	443 (23)^{a}	68	314 (18)^{b}
	Weight	14	1160 (194)^{a}	27	987 (197)^{ab}	35	1071 (120)^{a}	68	528 (103)^{b}
Golden Shiner	Length	-	----	2	160 (23)	3	183 (23)	23	135 (6)
	Weight	-	----	2	45 (5)^{a}	3	96 (33)^{b}	23	24 (5)^{a}
White Crappie	Length	-	----	-	----	-	----	1	245 (-)
	Weight	-	----	-	----	-	----	1	240 (-)
Black Crappie	Length	4	261 (30)^{ab}	20	299 (8)^{a}	8	234 (35)^{b}	57	213 (8)^{c}
	Weight	4	338 (86)^{ab}	20	437 (34)^{a}	8	295 (91)^{ab}	57	182 (18)^{b}
Flathead Catfish	Length	1	570 (-)	1	692 (-)	7	521 (28)	21	583 (25)
	Weight	1	2270 (-)	1	4620 (-)	7	2003 (347)	21	2778 (397)
Tilapia	Length	-	----	3	242 (8)	1	237 (-)	28	221 (7)
	Weight	-	----	3	307 (18)	1	310 (-)	28	243 (36)

Table 11. Mean total length (mm) and weight (g), and number of each species measured from spring gill netting and electrofishing samples in Lake Pleasant 2001-2004. Standard error is in parentheses. Superscript letters indicate mean lengths or weights that differ (ANOVA; *P* < 0.10) among years for a given species.

		2001		2002		2003		2004	
		N	Mean (SE)	N	Mean (SE)	N	Mean (SE)	N	Mean (SE)
Common Carp	Length	85	569 (8)^{a}	100	548 (11)^{ab}	225	540 (6)^{b}	133	549 (7)^{ab}
	Weight	85	2492 (89)^{a}	100	2341 (87)^{ab}	221	2048 (53)^{c}	133	2177 (72)^{bc}
Red Shiner	Length	-	----	-	----	-	----	-	----
	Weight	-	----	-	----	-	----	-	----
Threadfin Shad	Length	31	99 (1)^{a}	23	105 (3)^{a}	39	119 (7)^{ab}	8	135 (14)^{b}
	Weight	3	10 (1)	2	50 (30)	38	23 (4)	8	31 (9)
Channel Catfish	Length	60	471 (13)	55	489 (10)	37	438 (24)	31	457 (23)
	Weight	60	1282 (103)	55	1327 (85)	37	1078 (102)	31	1191 (150)
Green Sunfish	Length	49	97 (5)^{a}	282	85 (1)^{b}	56	106 (5)^{ac}	143	108 (2)^{c}
	Weight	46	28 (6)^{a}	274	12 (1)^{b}	56	33 (7)^{a}	143	27 (2)^{a}
Bluegill	Length	137	104 (2)^{a}	84	100 (3)^{a}	212	122 (2)^{b}	147	114 (3)^{b}
	Weight	125	27 (2)^{ac}	82	23 (3)^{a}	211	44 (2)^{b}	147	35 (3)^{c}
Redear Sunfish	Length	1	280 (-)	9	196 (24)^{ab}	49	167 (8)^{a}	23	204 (10)^{B}
	Weight	1	509 (-)	9	159 (45)^{ab}	49	122 (20)^{a}	23	184 (32)^{b}
Sunfish Hybrid	Length	12	205 (18)^{a}	41	102 (7)^{b}	160	104 (2)^{b}	2	108 (7)^{b}
	Weight	11	248 (53)^{a}	41	34 (11)^{b}	160	29 (3)^{b}	2	20 (10)^{b}
Largemouth Bass	Length	236	235 (7)^{ab}	159	230 (9)^{ab}	416	241 (5)^{a}	270	215 (6)^{b}
	Weight	221	282 (18)^{a}	155	284 (5)^{a}	393	276 (14)^{a}	268	209 (19)^{b}
White Bass	Length	200	307 (5)^{a}	435	359 (1)^{b}	309	328 (4)^{c}	141	346 (5)^{d}
	Weight	200	394 (14)^{a}	435	588 (7)^{b}	307	479 (13)^{c}	141	569 (24)^{b}
Striped Bass	Length	23	413 (23)^{a}	36	377 (25)^{a}	33	487 (22)^{b}	35	345 (21)^{a}
	Weight	23	954 (109)^{a}	36	800 (168)^{a}	33	1442 (144)^{b}	35	645 (150)^{a}
Golden Shiner	Length	1	61 (-)	-	----	4	204 (5)	-	----
	Weight	0	----	-	----	4	100 (7)	-	----
White Crappie	Length	6	271 (40)	1	348 (-)	-	----	-	----
	Weight	6	368 (88)	1	490 (-)	-	----	-	----
Black Crappie	Length	3	205 (80)	-	----	8	234 (28)	4	249 (6)
	Weight	3	249 (218)	-	----	8	271 (88)	4	240 (4)
Flathead Catfish	Length	5	471 (24)^{a}	4	637 (24)^{b}	4	580 (22)^{ab}	5	599 (47)^{b}
	Weight	5	1411 (218)^{a}	4	2948 (333)^{b}	4	2625 (317)^{ab}	5	2896 (518)^{b}
Tilapia	Length	2	348 (42)^{a}	-	----	4	422 (10)^{b}	-	----
	Weight	2	974 (290)^{a}	-	----	4	1668 (129)^{b}	-	----

(ANOVA; $P < 0.10$) for most species in 2003 and all values (except black crappie and flathead catfish) were below the generally accepted optimal range of 95-105 (Murphy et al. 1991). Striped bass and redear sunfish W_r did not vary in fall among years.

Spring W_r for most species was lowest in 2002 (ANOVA; $P < 0.10$). Again, nearly all species were consistently below the optimal range, however declining weight due to spawning activities can easily influence values of W_r. Relative weight of largemouth bass, channel catfish, black crappie and some sunfish species did not vary among years during spring.

Evaluation of relative weight values by incremental length category (Appendix 15) indicates that, for most species, W_r increased for larger fish. However, values were generally below optimal levels in all size categories for most species.

Relative abundance (CPUE), PSD, and W_r of largemouth bass collected from various reservoirs in Arizona are presented in Table 14 for comparison purposes.

Table 12. Proportional stock density (PSD) of fish collected using electrofishing and gill netting in Lake Pleasant, 2000-2004. Confidence intervals (80%) are also presented (Gustafson 1988); an "I" indicates that sample size was too small to determine the 80% confidence interval.

	Fall				Spring			
	2000	2001	2002	2003	2001	2002	2003	2004
Common Carp	81 ± 9	98 ± 3	84 ± 6	89 ± 4	94 ± 5	99 ± 3	90 ± 2	98 ± 3
Channel Catfish	89 ± 10	93 ± 6	77 ± 9	78 ± 7	78 ± 8	91 ± 6	97 ± I	93 ± I
Green Sunfish	20 ± I	5 ± I	5 ± 3	10 ± 5	18 ± 8	2 ± 1	14 ± 8	8 ± I
Sunfish Hybrid	100 ± I		33 ± I	50 ± 30	67 ± I	13 ± 10	10 ± 4	
Bluegill	8 ± I	12 ± 5	17 ± 5	8 ± 2	4 ± 3	9 ± 4	22 ± 3	16 ± 5
Redear Sunfish		100 ± I	63 ± 13	47 ± 18	100 ± I	56 ± 30	45 ± 11	70 ± 13
Largemouth Bass	58 ± 7	56 ± 3	59 ± 3	45 ± 3	52 ± 3	61 ± 6	46 ± 3	36 ± 3
White Bass	86 ± 2	98 ± 1	83 ± 2	60 ± 3	85 ± 2	100 ± 1	88 ± 2	100 ± 3
Striped Bass	36 ± 22	35 ± 15	41 ± 13	50 ± 9	12 ± I	47 ± 13	67 ± 13	18 ± 11
Black Crappie	75 ± I	100 ± I	100 ± I	96 ± I	50 ± I		86 ± I	100 ± I
Flathead Catfish	100 ± I	100 ± I	43 ± I	71 ± 17	20 ± I	100 ± I	100 ± I	80 ± I

Table 13. Relative weight (Wr) of fish collected using electrofishing and gill netting in Lake Pleasant, 2000-2004. Standard errors are in parentheses. Superscript letters indicate Wr values that differ (ANOVA; $P < 0.10$) among years (within a season) for a given species.

	Fall				Spring			
	2000	2001	2002	2003	2001	2002	2003	2004
Common Carp	100 (2)^{a}	99 (1)^{ab}	96 (1)^{b}	91 (1)^{c}	95 (1)^{A}	94 (1)^{A}	89 (1)^{B}	90 (1)^{B}
Channel Catfish	103 (2)^{a}	102 (3)^{ab}	96 (3)^{ab}	93 (2)^{b}	110 (2)	107 (3)	109 (4)	105 (4)
Green Sunfish	86 (2)^{ab}	93 (5)^{a}	74 (2)^{b}	89 (2)^{ab}	108 (3)^{A}	90 (2)^{B}	97 (3)^{B}	94 (2)^{B}
Sunfish Hybrid	84 (4)^{ab}	106 (5)^{a}	85 (7)^{ab}	82 (4)^{b}	93 (3)	91 (3)	103 (3)	79 (25)
Bluegill	86 (2)^{a}	87 (2)^{a}	81 (3)^{ab}	78 (1)^{b}	100 (1)^{A}	86 (3)^{B}	98 (1)^{A}	96 (2)^{A}
Redear Sunfish	----	91 (4)	86 (2)	85 (4)	110	81 (9)	92 (2)	92 (4)
Largemouth Bass	87 (1)^{a}	85 (1)^{ab}	87 (1)^{a}	84 (1)^{b}	86 (1)	83 (1)	86 (1)	86 (1)
White Bass	94 (1)^{a}	96 (1)^{b}	93 (1)^{a}	90 (1)^{c}	91 (1)^{A}	85 (1)^{B}	90 (1)^{A}	90 (1)^{A}
Striped Bass	85 (3)	78 (1)	83 (2)	81 (1)	92 (1)^{A}	84 (2)^{B}	87 (1)^{AB}	89 (3)^{AB}
Black Crappie	106 (7)^{a}	91 (2)^{b}	93 (7)^{b}	96 (2)^{ab}	93 (15)	----	101 (5)	96 (3)
Flathead Catfish	99	108	110 (4)	100 (2)	110 (5)^{A}	89 (3)^{B}	108 (5)^{A}	102 (4)^{AB}

Table 14. Relative abundance, PSD, and W_r of largemouth bass collected in various reservoirs in Arizona. Relative abundance is only reported for lakes that were sampled via electrofishing, which is the least biased gear for collecting largemouth bass (Bryan 2004). Standard errors (SE) and confidence intervals (CI) are reported when available.

Lake	Year	CPUE (SE)	PSD (80% CI)	W_r
Fall Sampling				
Alamo	2004	21.4	35 ± 3	94 (1)
Apache	2003		53	
Bartlett	2003	19.4 (0.4)	24	101 (1)
Canyon	2000		85	102 (1)
Havasu	2003	7.8	65 ± 7	90 (2)
Imperial	2003	16.6	60	88 (1)
Pleasant	2003	8.9 (1.5)	45 ± 3	84 (1)
Saguaro	2003		57	100 (1)
Spring Sampling				
Alamo	2004	13.1	49 ± 3	95 (1)
Pleasant	2004	8.9 (1.5)	36 ± 3	86 (1)
Roosevelt	2002		49	89 (1)

Age, Growth, Food Habits, and Fish Health

Otoliths of 64 largemouth bass, 54, white bass, and 74 striped bass were examined to determine age and growth. Otoliths of fish age 1 or less proved easiest to read, as there was over 95% agreement for all species (Table 15). Although there was 100% agreement for older (> age 1) white bass, there was only 61% agreement for older largemouth bass and 35% agreement for older striped bass. A breakdown of ages for fish collected is also presented in Table 15. Length-at-age tables are presented in Appendix 16a-c.

Stomachs of 77 largemouth bass (mean TL = 274 ± 13 mm) and 33 white bass (mean TL = 355 ± 12 mm) were examined to determine diet of each species (Figure 20). Of the 77 largemouth bass, 39 (50.6%) had empty stomachs; six (18.2%) white bass had empty stomachs. Crayfish and insects dominated the diet of largemouth bass (58%), while the rest of their diet was comprised mostly of unidentified fish, sunfish, and shad. White bass diet consisted mostly of threadfin shad (72%) or other fish (3%), with crayfish and insects making up 19% of their diet.

Tissue samples collected from the 60 largemouth bass tested negative for LMBV and other pathogens (Table 16).

Table 15. Percent agreement among three independent readers of otoliths, and ages for fish collected in Lake Pleasant in 2003.

	Largemouth Bass		White Bass		Striped Bass	
	n	% Agree	n	% Agree	n	% Agree
< Age 1	33	100.0	23	95.7	26	96.2
> Age 1	31	61.3	31	100.0	48	35.4
Age 0	33		22		25	
Age 1	14		8		8	
Age 2	1		8		6	
Age 3	3		3		1	
Age 4	0		9		1	
Age 5	1		3		0	
Age 6	0		0		1	

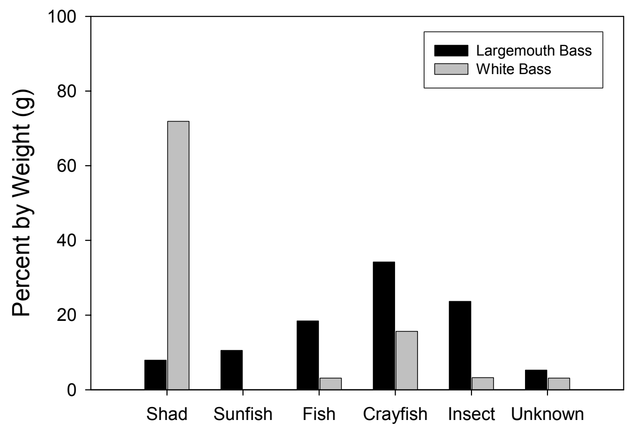

Figure 20. Percent by weight of prey items consumed by largemouth bass and white bass during August-November, 2002 in Lake Pleasant.

Table 16. Bacterial and viral diseases for which largemouth bass tested negative in Lake Pleasant in 2002.

Bacterial	Viral
Bacterial Furunculosis	*Largemouth Bass Virus*
Enteric Redmouth	*Hematopoietic Necrosis*
Enteric Septicemia	*Pancreatic Necrosis*
	Hemorrhagic Septicemia

Population Dynamics – Phase Comparison

Species Composition

Eighteen fish species (including sunfish hybrids) were collected in Phase I, compared to sixteen species in Phase II (Table 17). Yellow bullhead, goldfish, Sonora sucker, and mosquitofish were relatively rare in Phase I, but not caught in Phase II. Striped bass and flathead catfish were collected throughout Phase II, but were not found in the reservoir during Phase I.

Percent composition was significantly different between phases during fall ($P < 0.001$) but not during spring (Figure 21). In fall, common carp ($P = 0.027$), largemouth bass ($P = 0.05$), golden shiner ($P = 0.069$), and sunfish ($P = 0.007$) were all caught in higher proportions during Phase I than Phase II. Striped bass were caught in a higher proportion ($P = 0.014$) during fall in Phase II.

Table 17. Species collected via gill netting and electrofishing in Lake Pleasant during 1988-1989 (Phase I) and 2000-2004 (Phase II).

Species	Phase I	Phase II
Yellow Bullhead *Ameiurus natalis*	X	
Goldfish *Carassius auratus*	X	
Sonora Sucker *Catostomus insignis*	X	
Common Carp *Cyprinus carpio*	X	X
Red Shiner *Cyprinella lutrensis*	X	X
Threadfin Shad *Dorosoma petenense*	X	X
Mosquitofish *Gambusia affinis*	X	
Channel Catfish *Ictalurus punctatus*	X	X
Green Sunfish *Lepomis cyanellus*	X	X
Bluegill *Lepomis macrochirus*	X	X
Redear Sunfish *Lepomis microlophus*	X	X
Sunfish Hybrid *Lepomis spp.*	X	X
Largemouth Bass *Micropterus salmoides*	X	X
White Bass *Morone chrysops*	X	X
Striped Bass *Morone saxatilis*		X
Golden Shiner *Notemigonus crysoleucas*	X	X
White Crappie *Pomoxis annularis*	X	X
Black Crappie *Pomoxis nigromaculatus*	X	X
Flathead Catfish *Pylodictis olivaris*		X
Tilapia *Tilapia spp.*	X	X

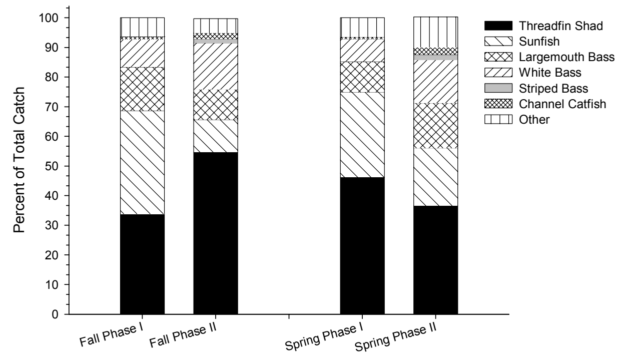

Figure 21. Seasonal percent composition of primary species caught in Lake Pleasant during Phase I and Phase II. The "Other" category includes yellow bullhead, goldfish, Sonora sucker, common carp, red shiner, mosquitofish, golden shiner, crappie, flathead catfish, and tilapia.

Relative Abundance

Relative abundance (CPUE) for fish susceptible to each gear type (Table 1) is reported in Table 18. For gill netting, mean CPUE in fall was over twice as high in Phase II than in Phase I (t-test; $P < 0.001$). Threadfin shad, striped bass, flathead catfish, and tilapia had higher abundances in Phase II (t-test; $P < 0.10$), while crappie and carp had higher abundances in Phase I (t-test; $P < 0.10$). Mean CPUE of white bass, channel catfish, and golden shiner were similar between the two phases.

In spring gill samples, mean CPUE did not differ between phases (Table 18). However, crappie, carp, golden shiner and white bass all had a higher CPUE in Phase I than in Phase II (t-test; $P < 0.10$). Mean CPUE of threadfin shad, striped bass, and flathead catfish were higher in Phase II (t-test; $P < 0.10$).

For electrofishing, mean CPUE in Phase I was higher than Phase II in both spring and fall (t-test; $P < 0.10$). Specifically, mean CPUE of crappie, carp, largemouth bass, and sunfish were all higher in Phase I (t-test; $P < 0.10$). Although mean CPUE of threadfin shad was much higher in Phase I than in Phase II, the high variability among sites in the first phase resulted in a non-significant t-test.

Size Structure

Mean length and weight of common carp, channel catfish, and largemouth bass (Table 19) was higher during fall of Phase II than in Phase I ($P < 0.10$). Conversely, mean length and weight of green sunfish and bluegill during fall were larger in Phase I. During spring, common carp, channel catfish, and bluegill were larger in Phase II ($P < 0.10$), while threadfin shad, green sunfish, hybrid sunfish, largemouth bass, and black crappie were all larger in Phase I ($P < 0.10$).

During both spring and fall, channel catfish had a higher mean PSD (Table 19) in Phase II than in Phase I ($P < 0.10$). Green sunfish had a higher PSD during fall of Phase I ($P = 0.090$), and largemouth bass had a higher mean PSD during fall of Phase II ($P = 0.030$). Redear sunfish had a higher mean PSD during spring of Phase II ($P = 0.084$).

Condition (W_r) of fish in Lake Pleasant was generally low (below the optimal level of 95-105) during fall of both phases, but somewhat higher during spring (Table 19). In fall common carp had a higher W_r in Phase II than in Phase I ($P < 0.001$), and bluegill and white bass were in better condition during Phase I ($P < 0.10$). In spring, bluegill and crappie had a higher Wr in Phase 2 ($P < 0.10$), while common carp, green sunfish, largemouth bass, and white bass all had higher mean W_r in Phase I ($P < 0.10$).

Table 18. Mean effort per net set (hour) or electrofishing site (15 minute unit), and CPUE (fish/hour for gill netting; fish/15 min for electrofishing) by season for fish collected in Lake Pleasant during Phase I and Phase II. Asterisks indicate values that are significantly higher within a season and gear type.

	Fall		Spring	
Gill Netting	Phase I	Phase II	Phase I	Phase II
Effort (hour)	*19.039 (0.504)**	*16.421 (0.123)*	*15.370 (0.230)*	*15.025 (0.117)*
Crappie	0.064 (0.014)*	0.034 (0.006)	0.050 (0.120)*	0.009 (0.003)
Common Carp	0.191 (0.040)*	0.087 (0.011)	0.471 (0.074)*	0.157 (0.018)
Threadfin Shad	0.000 (0.000)	1.852 (0.249)*	0.014 (0.005)	1.062 (0.373)*
Channel Catfish	0.068 (0.018)	0.091 (0.008)	0.086 (0.018)	0.077 (0.008)
White Bass	0.895 (0.119)	0.779 (0.070)	1.053 (0.837)*	0.485 (0.043)
Striped Bass	0.000 (0.000)	0.063 (0.008)*	0.000 (0.000)	0.057 (0.009)*
Flathead Catfish	0.000 (0.000)	0.014 (0.004)*	0.000 (0.000)	0.008 (0.002)*
Golden Shiner	0.002 (0.002)	0.004 (0.002)	0.021 (0.011)*	0.002 (0.001)
Tilapia	0.000 (0.000)	0.001 (0.004)*	0.000 (0.000)	0.003 (0.002)
Total Gill Net	*1.219 (0.137)*	*2.933 (0.278)**	*1.695 (0.197)*	*1.860 (0.380)*
Electrofishing				
Effort (15 min)	*1.140 (0.050)**	*1.013 (0.007)*	*1.384 (0.121)**	*1.036 (0.009)*
Yellow Bullhead	0.081 (0.081)	0.000 (0.000)	0.098 (0.074)	0.000 (0.000)
Sonoran Sucker	0.000 (0.000)	0.000 (0.000)	0.051 (0.051)	0.000 (0.000)
Crappie	0.700 (0.288)*	0.153 (0.067)	0.657 (0.297)*	0.032 (0.018)
Common Carp	8.506 (2.235)*	2.121 (0.305)	7.862 (1.692)*	3.962 (0.866)
Red Shiner	0.178 (0.101)	0.034 (0.025)	0.251 (0.148)	0.000 (0.000)
Threadfin Shad	103.923 (51.687)	23.486 (3.956)	122.926 (83.429)	1.008 (0.501)
Mosquitofish	0.000 (0.000)	0.000 (0.000)	0.033 (0.033)	0.000 (0.000)
Largemouth Bass	42.235 (5.858)*	11.296 (1.007)	26.956 (3.366)*	10.353 (0.950)
Sunfish	118.107 (19.110)*	13.386 (1.853)	102.096 (8.200)*	15.689 (1.708)
Total Electrofishing	*273.729 (59.213)**	*50.475 (5.237)*	*260.930 (81.402)**	*31.045 (2.639)*

Table 19. Mean total length (mm), weight (g), proportional stock density (PSD), and relative weight (W_r) of fish species collected using gill netting and electrofishing during fall and spring of Phase I (1987-1989) and Phase II (2000-2004). Standard errors are in parentheses. An asterisk indicates values that are statistically higher between phases within each variable (t-test; $P < 0.10$).

Fall	n		Length (mm)		Weight (g)		PSD		W_r	
	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II
Common Carp	267	390	397 (7)	547 (5)*	1029 (48)	2295 (46)*	77 (4)	88 (4)	91 (1)	96 (1)*
Threadfin Shad	50	1906	106 (5)	106 (0)	20 (2)*	14 (0)				
Channel Catfish	43	227	359 (15)	470 (7)*	550 (95)	1184 (51)*	26 (6)	84 (4)*	95 (2)	98 (1)
Green Sunfish	214	343	113 (2)*	95 (1)	33 (2)*	17 (1)	22 (1)*	10 (4)	81 (2)	82 (2)
Sunfish Hybrid	207	27	118 (2)	123 (8)	34 (2)	52 (11)	12 (4)	46 (21)	83 (2)	87 (3)
Bluegill	1178	719	109 (1)*	100 (1)	27 (1)*	23 (1)	7 (2)	13 (4)	89 (1)*	81 (1)
Redear Sunfish	3	55	142 (44)	203 (9)	104 (36)	201 (25)	50 (-)	70 (16)	79 (1)	86 (2)
Largemouth Bass	792	1169	218 (3)	226 (3)*	204 (10)	280 (12)*	33 (8)	55 (3)*	84 (1)	85 (1)
White Bass	506	1772	326 (3)	324 (2)	519 (11)	509 (7)	100 (1)	82 (8)	102 (1)*	93 (1)
Black Crappie	36	89	240 (12)	236 (7)	275 (35)	256 (20)	89 (6)	93 (6)	95 (2)	95 (1)

Spring	n		Length (mm)		Weight (g)		PSD		W_r	
	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II
Common Carp	267	543	435 (6)	548 (4)*	1320 (52)	2204 (36)*	72 (6)	95 (2)	93 (1)*	91 (1)
Threadfin Shad	18	101	143 (10)*	111 (3)	38 (5)*	24 (4)				
Channel Catfish	28	183	337 (21)	468 (8)*	474 (104)	1239 (54)*	42 (8)	89 (4)*	108 (10)	108 (1)
Green Sunfish	90	530	110 (4)*	94 (1)	37 (5)*	20 (1)	20 (3)	10 (4)	100 (5)*	94 (1)
Sunfish Hybrid	136	215	132 (2)*	110 (3)	48 (3)	41 (5)	26 (12)	23 (15)	96 (1)	100 (2)
Bluegill	948	580	107 (1)	113 (1)*	27 (1)	35 (1)*	5 (1)	11 (2)	90 (1)	96 (1)*
Redear Sunfish	5	82	156 (7)	182 (6)	64 (16)	148 (16)	0	68 (12)*	84 (14)	91 (2)
Largemouth Bass	674	1081	259 (3)*	232 (3)	279 (10)	261 (10)	42 (3)	49 (5)	88 (1)*	86 (1)
White Bass	324	1085	334 (3)	339 (2)	524 (13)	507 (6)	99 (1)	93 (4)	100 (1)*	88 (1)
Black Crappie	32	15	287 (12)*	232 (20)	441 (44)*	258 (59)	100 (0)	79 (15)	91 (2)	99 (4)*

Water Quality – Phase II

Physical Environment

Water level fluctuations in Lake Pleasant during Phase II followed a general pattern of rising from November - April and declining from May – October (Figure 22). Typically, the reservoir reaches its high in April/May and its low in October/November. Surface elevations ranged from a low of 484.5 m in October 2000 to a high of 513.5 m in April 2001. Fluctuations in water level ranged from 18 m in 2001 to 23.7 m in 2004.

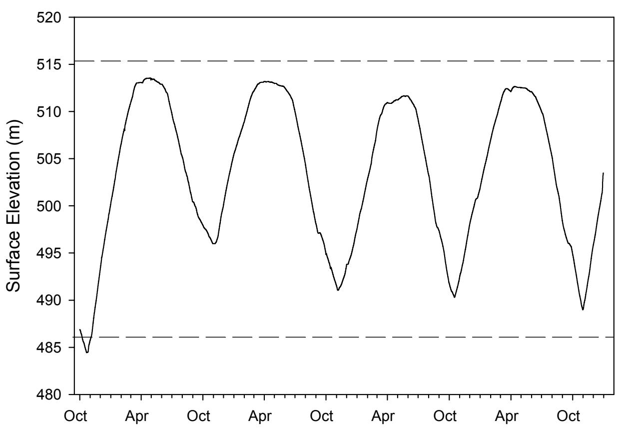

Figure 22. Water surface elevations at Lake Pleasant from October 2000 – December 2004. The dashed lines represent the level of the original Carl Pleasant Dam (485.9m) and current full pool (515.1m).

General Water Chemistry and Productivity

Surface water temperatures ranged from as low as 10.38^{o} C in February, 2001 to as high as 30.40^{o} C in August, 2003. Although overall mean surface temperature did not differ among years (ANOVA; P = 0.45), monthly mean temperatures varied considerably (ANOVA; $P <$ 0.05)(Table 20; see also graphical representation in Appendix 17).

Surface conductivity ranged from 0.730 mS/cm to 1.580 mS/cm over the course of the study. Mean surface conductivity was significantly lower in 2001 than in subsequent years (ANOVA; P < 0.001) and typically highest during winter months (Table 20).

Monthly mean surface dissolved oxygen varied significantly among years (ANOVA; $P <$ 0.05)(Table 20). Mean surface dissolved oxygen was higher in 2001 than all other years (ANOVA; P < 0.001). Dissolved oxygen did not follow a specific monthly pattern from year to year, but was generally highest during spring months (Appendix 17).

Mean surface pH was highest in 2003 (ANOVA; P < 0.001), but only varied from 8.35 in 2001 to 8.51 in 2003. Monthly surface pH also varied significantly (ANOVA; P < 0.05)(Table 20). Similar to dissolved oxygen, mean pH values were generally highest in spring (Appendix 17).

A thermocline is defined as the depth at which there is maximum change in water temperature (of at least 1^{o}C in 1 m), which creates a zone of warm water (epilimnion) above a zone of cooler water (hypolimnion; Wetzel 1975). In general, the thermocline in Lake Pleasant developed in April at depths ranging from 5 m (Agua Fria) to 13 m (Honeymoon Cove). The reservoir typically remained stratified through October, with the depth of the thermocline increasing throughout the summer months (Figure 23). The entire reservoir was usually homeothermic during the months of November - March.

Dissolved oxygen at the thermocline generally ranged from 3 – 7 mg/L during April – June, but dropped below 1 mg/L at the thermocline during July – October. In the hypolimnion (below the thermocline), dissolved oxygen levels dropped to nearly zero during summer months. Mean conductivity and pH values decrease significantly from the surface to the thermocline (ANOVA; P < 0.001).

Mean secchi depth (light penetration) did not vary by basin except in 2003, when secchi values were higher in the lower basin (ANOVA; P = 0.01; Figure 24). Overall mean secchi depth was significantly higher in 2002 (3.5

Table 20. Mean monthly surface water quality at Lake Pleasant, 2001-2003. Standard error is in parentheses. Superscript letters indicate values that are significantly different among years (ANOVA; $P < 0.05$).

Month	Parameter	2000	2001	2002	2003
January	Temperature (°C)		11.42 (0.02)^{a}	11.83 (0.01)^{b}	12.20 (0.03)^{c}
	Conductivity (mS/cm)		0.929 (0.01)^{a}	0.957 (0.01)^{b}	1.228 (0.01)^{c}
	Dissolved Oxygen (mg/L)		11.48 (0.06)^{a}	11.30 (0.15)^{a}	6.36 (0.09)^{b}
	PH		8.21 (0.05)^{a}	8.27 (0.01)^{ab}	8.36 (0.04)^{b}
February	Temperature (°C)		11.10 (0.05)^{a}	10.57 (0.08)^{a}	13.49 (0.29)^{b}
	Conductivity (mS/cm)		0.891 (0.01)^{a}	0.956 (0.01)^{b}	1.544 (0.01)^{c}
	Dissolved Oxygen (mg/L)		12.69 (0.09)^{a}	9.30 (0.18)^{b}	5.39 (0.35)^{c}
	PH		8.34 (0.02)	8.25 (0.05)	8.38 (0.09)
March	Temperature (°C)		12.89 (0.13)^{a}		14.68 (0.25)^{b}
	Conductivity (mS/cm)		0.845 (0.02)^{a}		1.204 (0.02)^{b}
	Dissolved Oxygen (mg/L)		11.21 (0.12)^{a}		14.12 (0.47)^{b}
	pH		8.38 (0.05)		8.48 (0.05)
April	Temperature (°C)		18.36 (0.16)^{a}	18.93 (0.21)^{b}	
	Conductivity (mS/cm)		0.872 (0.01)^{a}	0.969 (0.01)^{b}	
	Dissolved Oxygen (mg/L)		7.60 (0.31)^{a}	10.50 (0.09)^{b}	
	pH		8.46 (0.03)^{a}	8.62 (0.02)^{b}	
May	Temperature (°C)		24.84 (0.26)^{a}	20.76 (0.18)^{b}	20.10 (0.23)^{b}
	Conductivity (mS/cm)		0.957 (0.01)^{a}	1.091 (0.01)^{b}	1.278 (0.01)^{c}
	Dissolved Oxygen (mg/L)		12.51 (0.36)^{a}	9.82 (0.07)^{b}	7.90 (0.26)^{c}
	pH		8.19 (0.12)^{a}	8.45 (0.07)^{ab}	8.64 (0.06)^{b}
June	Temperature (°C)		26.94 (0.17)	26.26 (0.26)	26.48 (0.21)
	Conductivity (mS/cm)		0.774 (0.01)^{a}	1.159 (0.01)^{b}	0.880 (0.08)^{a}
	Dissolved Oxygen (mg/L)		7.79 (0.02)^{a}	8.04 (0.06)^{a}	10.38 (0.13)^{b}
	pH		8.71 (0.12)	8.64 (0.05)	8.63 (0.02)
July	Temperature (°C)		29.28 (0.14)	28.85 (0.18)	29.38 (0.20)
	Conductivity (mS/cm)		0.947 (0.01)^{a}	1.197 (0.01)^{b}	0.767 (0.02)^{c}
	Dissolved Oxygen (mg/L)		7.60 (0.04)^{a}	7.38 (0.03)^{b}	7.73 (0.09)^{a}
	pH		8.46 (0.01)	8.50 (0.06)	8.47 (0.02)
August	Temperature (°C)		28.82 (0.03)^{a}	28.78 (0.13)^{a}	30.10 (0.18)^{b}
	Conductivity (mS/cm)		0.953 (0.01)^{a}	1.198 (0.01)^{b}	.912 (0.02)^{c}
	Dissolved Oxygen (mg/L)		7.25 (0.06)^{a}	6.70 (0.04)^{b}	7.64 (0.06)^{c}
	pH		8.75 (0.00)^{a}	8.32 (0.05)^{b}	8.63 (0.01)^{c}
September	Temperature (°C)			27.71 (0.22)	
	Conductivity (mS/cm)			1.074 (0.01)	
	Dissolved Oxygen (mg/L)			9.14 (0.26)	
	pH			8.35 (0.03)	
October	Temperature (°C)		22.99 (0.13)^{a}	23.04 (0.09)^{a}	24.92 (0.13)^{b}
	Conductivity (mS/cm)		0.956 (0.01)^{a}	0.996 (0.01)^{b}	
	Dissolved Oxygen (mg/L)		7.77 (0.30)^{a}	6.38 (0.13)^{b}	5.98 (0.20)^{c}
	pH		8.42 (0.05)^{a}	7.91 (0.05)^{b}	8.33 (0.07)^{a}
November	Temperature (°C)	15.32 (0.06)^{a}	19.08 (0.05)^{b}	16.47 (0.03)^{c}	
	Conductivity (mS/cm)	0.986 (0.01)^{a}	0.959 (0.01)^{b}	1.393 (0.01)^{c}	
	Dissolved Oxygen (mg/L)	9.47 (0.15)^{a}	8.40 (0.12)^{b}	8.79 (0.17)^{b}	
	pH	7.47 (0.06)^{a}	8.31 (0.03)^{b}	8.08 (0.07)^{c}	
December	Temperature (°C)	12.75 (0.05)^{a}	13.60 (0.02)^{b}	13.99 (0.05)^{c}	
	Conductivity (mS/cm)	0.975 (0.01)^{a}	0.961 (0.01)^{b}	1.231 (0.01)^{c}	
	Dissolved Oxygen (mg/L)	11.53 (0.39)^{a}	11.22 (0.40)^{a}	7.14 (0.34)^{b}	
	pH	8.04 (0.05)^{a}	8.39 (0.02)^{b}	8.52 (0.02)^{c}	

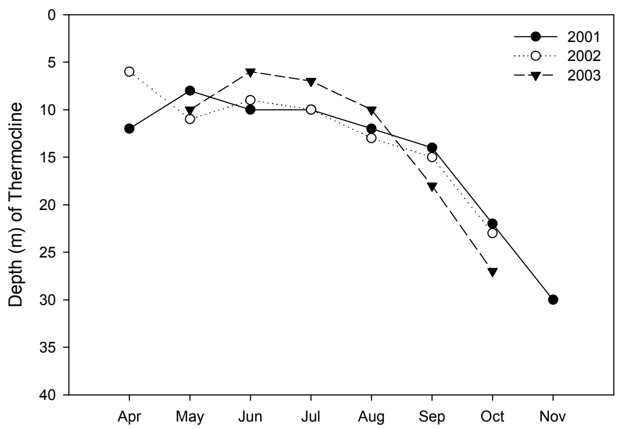

Figure 23. Median monthly depth of the thermocline in Lake Pleasant, 2001-2003.

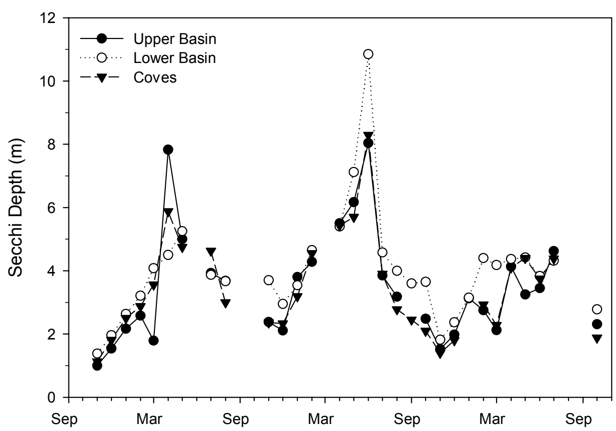

Figure 24. Mean secchi depth (m) by basin in Lake Pleasant, 2001-2003.

m) than in 2003 (4.3 m)(ANOVA; P = 0.017). Mean monthly secchi was highest during April through July in all years (Appendix 18).

Chlorophyll-a is a measurement of the primary productivity of the reservoir. Chlorophyll levels followed a similar pattern during 2001–2003; increasing during spring, decreasing in summer, and increasing again in fall (Appendix 18). Mean chlorophyll levels did not differ by basin (Figure 25), but did differ by year; mean chlorophyll in 2003 (6.77) was higher than any other year (ANOVA; $P <$ 0.001).

Mean chlorophyll levels in each basin and in coves was plotted against Agua Fria inflow (Figure 26) and reservoir elevation (Figure 27) to determine if there was a relationship between those variables. For Agua Fria inflow, there was a significant positive correlation with chlorophyll levels in each basin; upper (Spearman Rank Correlation; P =0.05), lower (P = 0.001), and coves (P =0.005). Reservoir elevation was only significantly correlated with mean chlorophyll levels in coves (Spearman Rank Correlation; P = 0.016).

Metals, Ions, and Nutrients

Concentrations of major metals, ions, and nutrients occurring in Lake Pleasant were analyzed by CAP and are presented in Appendix 19a-19b. Most parameters occurred at a non-detectable level in Lake Pleasant. Only four parameters differed among years; calcium and chloride were higher in 2004 than in 2001 (ANOVA; P = 0.028 and P = 0.009, respectively), copper was higher in 2002 than all other years (P = 0.012), and Indeno (1,2,3,c,d) Pyrene was only detected in 2003 (P = 0.049). Only copper levels in 2001 exceeded EPA water quality criterion (1.0 mg/l); all other water quality parameters were within EPA standards (Thurston et al. 1979).

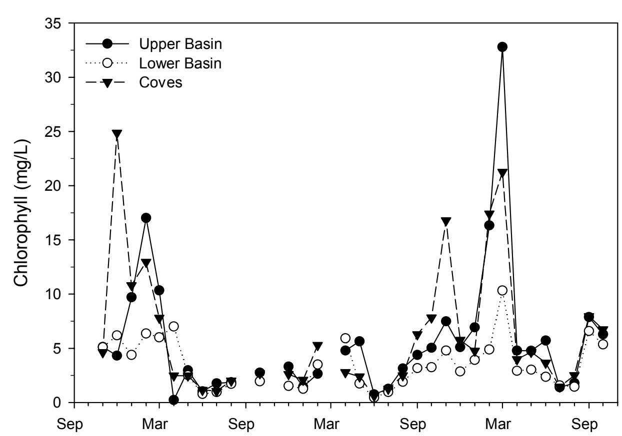

Figure 25. Mean chlorophyll (mg/l) by basin in Lake Pleasant, 2001-2003.

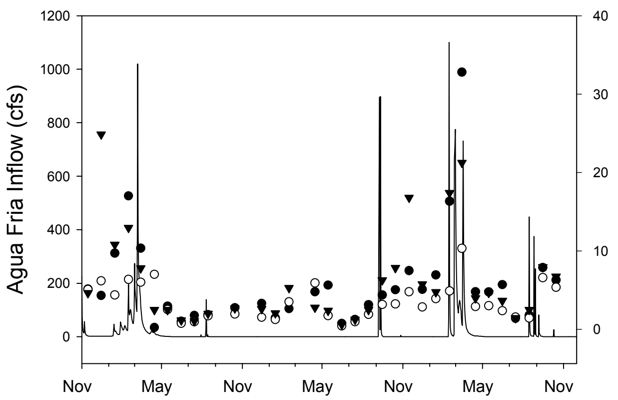

Figure 26. Mean chlorophyll (mg/L) plotted against Agua Fria inflow (solid line) in Lake Pleasant, November 2000 – October 2003. Closed circles represent chlorophyll levels measured in the upper basin, open circles represent chlorophyll in the lower basin, and triangles represent chlorophyll measured in coves.

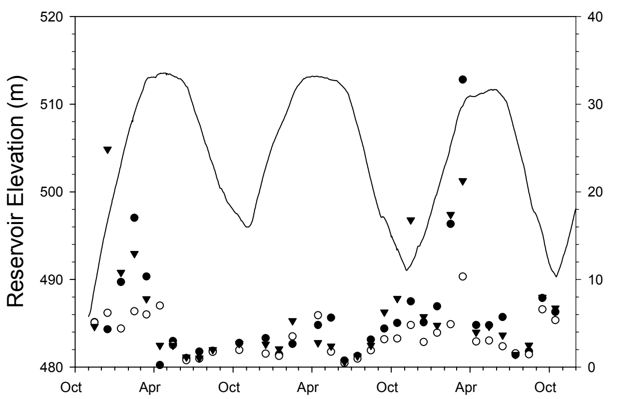

Figure 27. Mean chlorophyll (mg/L) plotted against reservoir elevation (solid line) in Lake Pleasant November 2000 – October 2003. Closed circles represent chlorophyll levels measured in the upper basin, open circles represent chlorophyll in the lower basin, and triangles represent chlorophyll measured in coves.

Water Quality – Phase Comparison

Physical Environment

Annual water level fluctuations were more prominent in Phase II than in Phase I (Figure 28). Mean yearly fluctuations prior to the construction of New Waddell Dam (Phase I) were only 3.75 m, while in Phase II, the mean yearly fluctuations were 20.8 m. During Phase I, the highest water levels occurred in March, while the lowest occurred in July. In Phase II, the highest mean elevation was in May and the lowest was in October.

General Water Chemistry and Productivity

Mean surface water temperature did not differ between phases (Figure 29). In Phase I, the minimum temperature recorded was 8.0^{o}C in January 1989, and the maximum temperature recorded was 32.9 in June 1988.

Mean surface conductivity, dissolved oxygen, and pH were all higher in Phase II than in Phase I (ANOVA; $P < 0.001$). Monthly mean surface dissolved oxygen and pH followed similar patterns between the two phases (Figure 29), however, conductivity was greatly influenced by the new water source in Phase II (CAP water).

The median monthly depth of the thermocline was shallower in Phase I than in Phase II (Figure 30). In addition, the thermocline formed a month earlier and dissipated a month earlier in Phase I.

Mean secchi depth (light penetration) varied in each of the basins between phases (t-test; $P < 0.001$). In each case, mean secchi depth was deeper in Phase II than in Phase I (Figure 31).

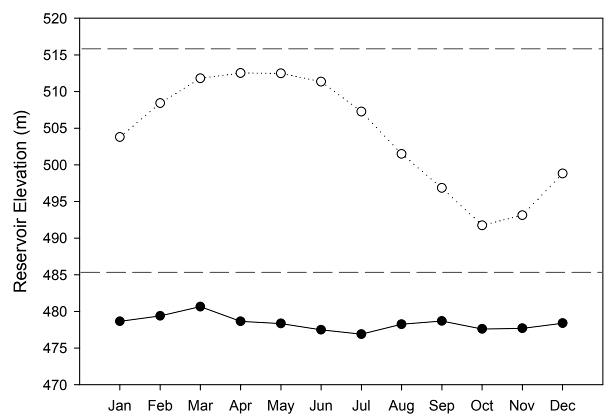

Figure 28. Mean monthly reservoir elevation (m) in Lake Pleasant during Phase I (closed circles) and Phase II (open circles). The dashed lines represent the level of the original Carl Pleasant Dam (485.1m) and current full pool (515.7m).

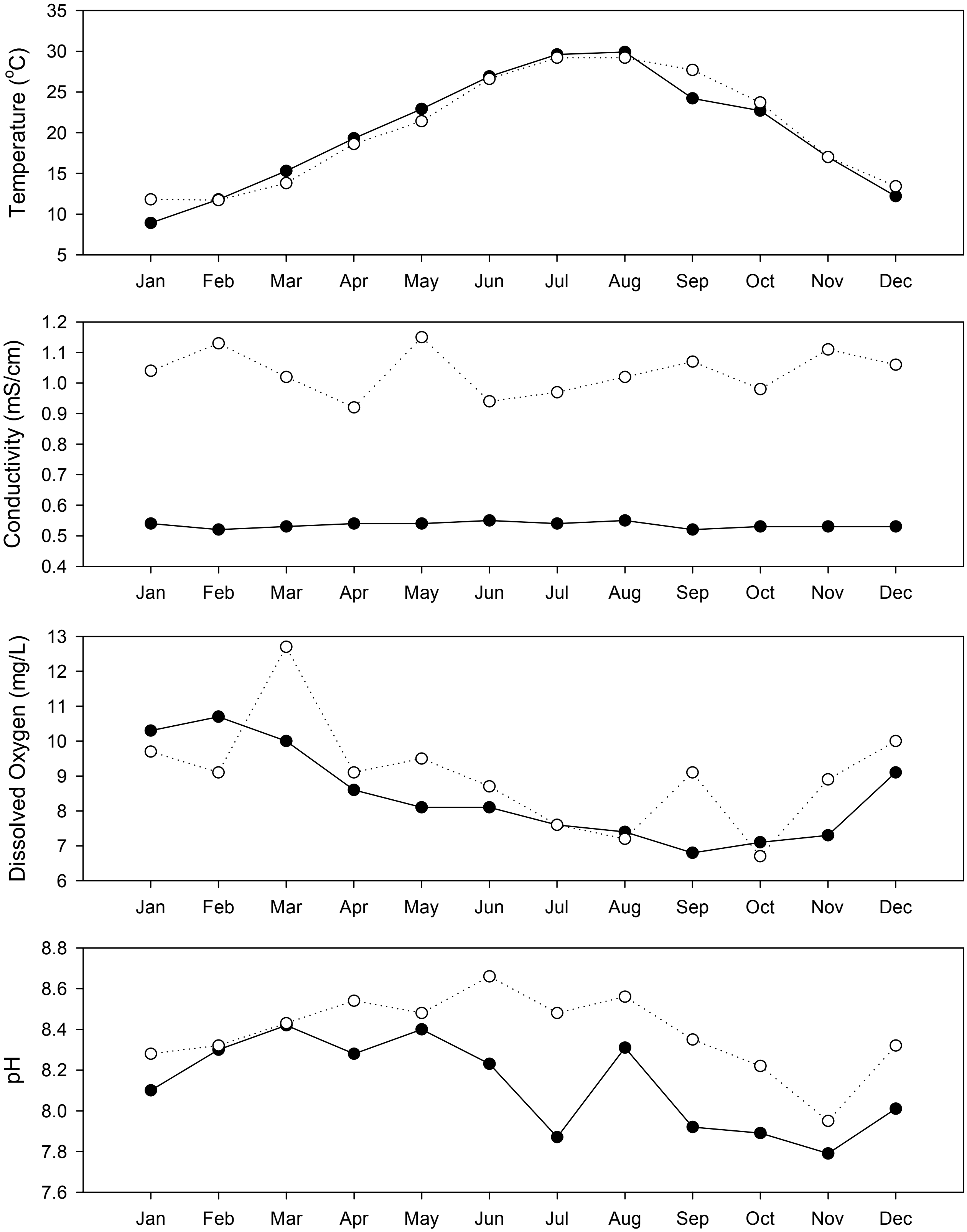

Figure 29. Mean monthly surface water quality at Lake Pleasant during Phase I (closed circles) and Phase II (open circles).

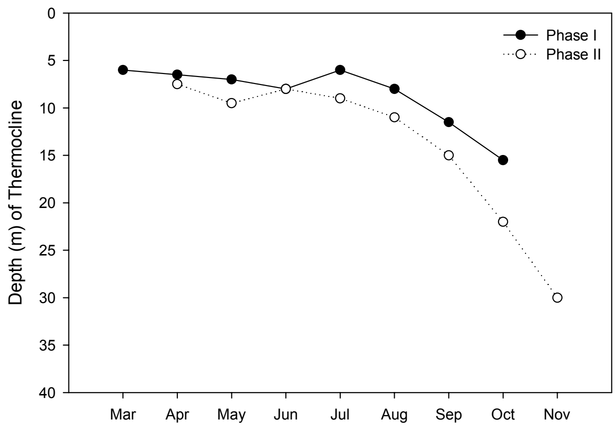

Figure 30. Median monthly depth of the thermocline in Lake Pleasant during Phase I and Phase II.

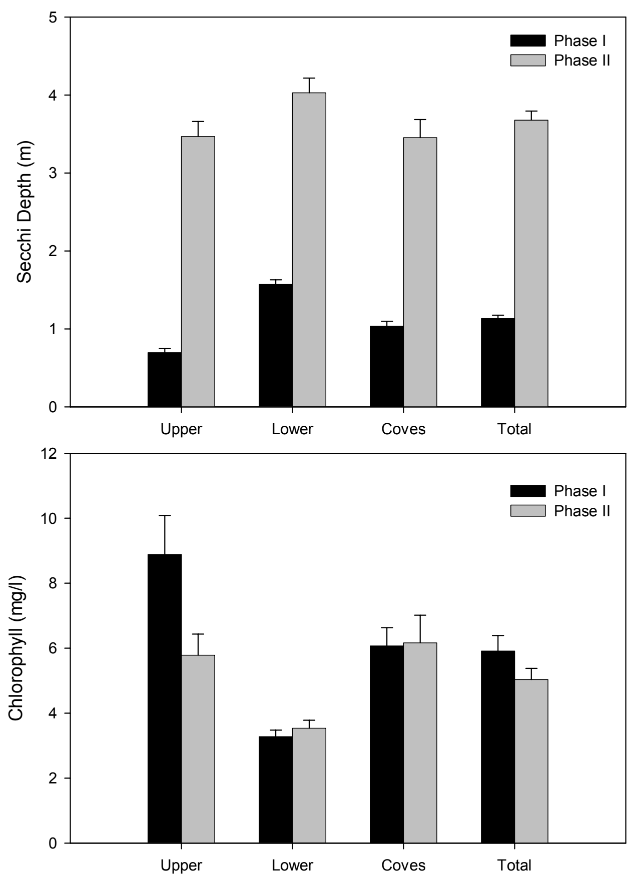

Figure 31. Mean secchi depth (m) and chlorophyll (mg/l) by basin in Lake Pleasant during Phase I and Phase II.

In Phase I, overall mean secchi depth was 1.1 m (SE = 0.04), while in Phase II, mean secchi depth was 3.7 m (SE = 0.12)(t-test; $P < 0.001$). Mean monthly secchi depth differed in each month between phases (t-test; $P < 0.001$) and is presented in Appendix 20.

Mean chlorophyll only differed in the upper basin when values from the two phases were compared (Figure 31). During Phase I, mean chlorophyll in the upper basin was 8.9 mg/l (SE = 1.2), while during Phase II, mean chlorophyll in the upper basin was 5.8 mg/l (SE 0.65)(t-test; $P = 0.14$). Overall mean chlorophyll did not differ between phases. Mean monthly chlorophyll (Appendix 20) was higher in Phase I during May – July (t-test; P < 0.04), but higher in Phase II during March and October (t-test; P < 0.003). Mean monthly chlorophyll did not correlate with reservoir elevation or Agua Fria inflow during Phase I. (Spearman Rank Correlation).

Metals, Ions, and Nutrients

Several metals, ions, and nutrients differed between the two phases (Table 21). Mean alkalinity and total phosphorous were both higher in Phase I than in Phase II (t-test; P < 0.001). Calcium, chloride, magnesium, sodium, and sulfate were all higher in Phase II than in

Table 21. Mean concentrations (SE) of metals, nutrients, and contaminants measured in Lake Pleasant during both Phase I and Phase II. All units are mg/l unless otherwise noted. Asterisks indicate values that are significantly higher between phases (t-test; $P < 0.05$).

	Phase I	Phase II
Alkalinity	171.10 (5.87)*	124.04 (4.20)
Ammonia	0.03 (0.02)	0.00 (0.00)
Calcium	25.85 (6.55)	71.28 (0.70)*
Chloride	27.38 (1.82)	81.54 (2.35)*
Copper	0.04 (0.01)	0.02 (0.02)
Iron	0.21 (0.06)	0.83 (0.79)
Magnesium	14.72 (3.01)	28.81 (1.16)*
Manganese	0.07 (0.02)	0.01 (0.01)
Total Nitrogen	0.31 (0.11)	0.02 (0.01)
Nitrate (as N)	0.03 (0.03)	0.00 (0.00)
Orthophosphates	0.02 (0.01)	0.01 (0.01)
Total Phosphorous	0.07 (0.01)*	0.00 (0.00)
Potassium	2.87 (0.63)	3.97 (0.55)
Sodium	28.15 (7.90)	76.67 (11.41)*
Sulfate	61.48 (3.86)	248.56 (3.97)*
Turbidity (NTU)	7.79 (3.93)	1.81 (0.50)

Phase I (t-test; $P < 0.03$). All values were within EPA standards for freshwater (Thurston et al. 1979).

DISCUSSION - PHASE II

Although patterns in data from four years of collection may provide indicators of a developing trend, statistical differences in data may more likely be attributed to the natural variability of populations. We offer possible reasons for the differences observed in the data, realizing that only consistent collection of these data over time will provide evidence of a trend.

Angler Surveys

The intensive angler survey component of this study produced nearly 5,600 interviews on 322 survey days. There were no interviews on twenty-eight of those surveys days, likely resulting from such factors as poor weather conditions or unpopular time-of-day (for anglers). An overwhelming majority of anglers fished from boats over the course of the study. This can be attributed to the large size of the reservoir, the few accessible points for shoreline fishing, and the poor success rates for shoreline anglers.

Although most anglers were adults, the proportion of young anglers (under the age of 15) increased by over 4% over the four-year period. It is encouraging to note this increase, as youth participation in angling is decreasing in most cases around the United States (Matthews 1996).

Angler Preferences

A frequent challenge for researchers is to identify and quantify angler preferences to help managers determine the demand for different types of fishing opportunities (Connelly et al. 2001). For many anglers, Lake Pleasant has always been known as a largemouth bass reservoir, and from 2001-2003 over 45% of all anglers fished solely for the popular sportfish. However, in 2004, angler preferences shifted towards a more generalist attitude (Bryan 1977; Hahn 1991; Wilde and Ditton 1994). The proportion of anglers fishing for largemouth bass dipped below 40% in 2004, while the proportion of anglers that had no specific preference increased by 14% (to 42%) in 2004. The proportion of anglers targeting crappie and bluegill (or sunfish) also increased. This shift in angler preferences indicates that Lake Pleasant may no longer be the premier largemouth bass reservoir in central Arizona, and that less skilled or "family" anglers now frequent the lake in higher numbers. Personal communication with anglers suggests that those specifically targeting largemouth bass are traveling to other lakes to find quality largemouth bass opportunities in Arizona.

A frequent complaint of anglers is the emergence of striped bass as a dominant species in the reservoir. Although our data indicates that striped bass represent a very small proportion of fish (by number) in the reservoir, the belief of many anglers is that predation and competition has caused a decline of more popular sportfish, namely largemouth bass (personal communication; see also Churchill et al. 2002). Despite the desire of anglers to rid the reservoir of striped bass, surprisingly few actually targeted this large predator in Lake Pleasant. Also, the number of anglers targeting white bass was low relative to their high abundance in the reservoir. Catfish anglers represented a small proportion of total anglers at the reservoir.

Angling Pressure

Entry counts at the three primary access points indicated that the number of anglers visiting Lake Pleasant did not differ among years. However, the numbers may be underestimated because all vehicles entering the park are not always counted (due to non-compliance at self-pay stations and alternative access points). The ten-lane ramp at South Park and the Marina boat ramps receive the highest amount of pressure, but the lowest proportions of anglers.

Conversely, estimates of angling pressure from creel surveys decreased by 44% from 2001 to 2004. The decrease in angling pressure can partially be attributed to a decrease in mean length of angler day (by an average of 16 minutes per angler), which may be a result of decreasing angler catch and satisfaction. Alternatively, the decrease in average angler day could simply be reflective of the downward trend of fishing popularity nationwide (Fedler and Ditton 2001).

However, the primary reason for the decreasing pressure may be related to the change in our survey protocol. Estimates of angling pressure were very similar from 2002-2004, when survey days were four hours in length. In 2001, survey days were six hours in length. Consequently, there were no days in 2001 when there were no anglers interviewed. In 2002-2004, a number of survey days resulted in no anglers being interviewed (because of the shorter day). This makes our estimates from 2002-2004 somewhat conservative, and the most accurate estimate may be the mean of all years combined.

Regardless, estimates of pressure throughout the study indicate that Lake Pleasant remains one of the most used lakes in Arizona (AGFD, unpublished data), emphasizing the importance of this fishery to the State.

Angler Catch and Harvest

Mean total CPUE decreased in each year of the study, with an overall 25% decrease during the four years. The decreasing trend of angler CPUE should be alarming to managers since most angler opinion surveys indicate that anglers are more satisfied when they catch more fish (Fedler and Ditton 1994; Wilde and Ditton 1994; Connelly et al. 2001). The decrease in overall CPUE can be directly related to the consistent decrease in spring catch rates. This may be due to the lack of spring runoff in 2002-2004, and consequently lower catch rates of species such as white bass that rely on heavy flows for spawning.

Perhaps a more accurate assessment of catch rates is to compare CPUE for anglers targeting a specific species. Although many anglers are satisfied if they catch a fish of any species (Wilde and Ditton 1994), assessing the catch rate for targeted species reduces the bias associated with "incidental" catch.

Anglers targeting largemouth bass experienced a steady decline in catch rates during Phase II. There are several potential explanations for the decline, and a combination of factors are likely responsible. It must first be noted that spring and fall abundances (as measured by electrofishing) fluctuate widely, but do not follow a similar decreasing pattern like that of angler CPUE. Therefore, decreased angler catch rates do not appear to be a product of a decreasing population. Instead, decreasing habitat availability (i.e. lack of cover) may cause largemouth bass to be less susceptible to anglers (Wanjala et al. 1986). Cover, such as underwater trees and other vegetation, is being uprooted with constant water level fluctuations. Also, campers in the Regional Park have removed trees along much of the western shoreline for firewood (personal observation). In addition to a lack of cover, studies have shown that largemouth bass become less vulnerable to angling due to selective breeding (Garrett 2002). As pressure continues to be high in Lake Pleasant, largemouth bass may be learning avoidance behaviors and the ability to discern natural prey from artificial replicas.

Anglers targeting white bass enjoyed higher catch rates than any other specialized angler. Although catch rates decreased by over 50% from 2001 to 2003, CPUE increased. Highest catch rates should occur during spring when inflow from tributaries triggers a spawning event (DiCenzo and Duval 2002), or in spring following a high precipitation year when recruitment is high (Willis et al. 2002). Spring 2001 catch rates followed the first scenario, as catch rates were higher than any other period during this study, and spring 2001 inflow was high. However, white bass catch rates were also very high in summer during 2002 and 2004 (rather than spring); years when inflow was relatively high during the previous spring. Catch rates were lowest in 2003, following a year of almost no runoff. It appears that anglers targeting white bass will be most successful the year following a high spring runoff event.

Sunfish anglers experienced very high catch rates in 2003, two years following the high runoff year of 2001. Multiple species anglers also had their highest catch rates during 2003. It is not surprising that these two angling groups would show similar patterns in catch rates, as many "generalist" anglers are using baits such as earthworms and corn, which are most often used to catch species such as sunfish. Abundance estimates indicate that sunfish species likely had a very strong year-class in 2001 (based electrofishing catch of 1-2 year-old fish in 2003) and anglers caught those fish in 2003.

The few anglers that targeted striped bass were largely unsuccessful. However, those anglers not targeting striped bass did have some success (CPUE = 0.01 fish/h; SE = 0.01). This indicates that striped bass were more often caught incidentally (i.e. when fishing for another species), than when the fish was actually targeted. However, catch rates were extremely low in either case.

Overall, percent harvest increased by 8% from 2001 to 2004. This increase, however, is not influenced by largemouth bass harvest, as it averaged only 18% over the four years. Many anglers suggest that the reason for a declining catch rate and smaller size of largemouth bass is due to overexploitation, but the 18% harvest in Lake Pleasant is low compared to other reported values in the United States (Bulak and Crane 2002; Krause 2002; Wilson and Dicenzo 2002). Yeager and Van Den Avyle (1978) concluded that overharvest is generally indicated when annual exploitation exceeds the expectation of natural death by a considerable margin. Although we did not estimate natural mortality of largemouth bass in Lake Pleasant, there is very little chance that harvest exceeded natural mortality by a considerable margin. Interestingly, the high rate of catch-and-release practiced in Lake Pleasant actually has the potential to negatively affect the size-structure of the fishery by causing overabundance, eventually leading to reduced size and slow growth (Perry et al. 1995).

Harvest of crappie, white bass, channel catfish, and striped bass were all over 40%, but within other values reported (Larson et al. 1991; Santucci et al. 1994; Schultz and Robinson 2002a, 2002b). In fact, this higher rate of exploitation may be helping to maintain healthy populations (especially of white bass).

Whole-lake estimates of catch and harvest provide absolute numbers that give managers a better idea of the magnitude of exploitation in the reservoir. Estimates of catch and harvest decreased by over 50% from 2001 to 2002, and were relatively steady thereafter. As with estimates of total effort, error associated with the change in sampling protocol (from a 6-hour day to a 4-hour day) likely affected our estimates of catch and harvest and the true value is likely a mean of all years combined. Regardless, catch of largemouth bass and white bass constituted 78-90% of the total catch, and harvest of white bass made up 49-71% of the total harvest. The estimate of crappie harvest was equal to that of largemouth bass in 2004.

Angler Success

Further evidence of the declining fishery at Lake Pleasant was the decrease in successful anglers from 2001-2003, although success increased again in 2004. Success (measured as an angler catching at least one fish) decreased by 9% from 2001 to 2003. Ideally, fisheries managers in Arizona would like anglers to have a 50-50 chance of catching a fish (personal communication), however in Lake Pleasant, success was less than 50% from 2002-2004. Not surprisingly, boat anglers were much more successful than shore anglers at Lake Pleasant. Poor success of shore anglers is likely caused by steep shorelines, lack of fish-holding cover near the shorelines, and a lower skill level.

For individual species, success (measured as an angler catching at least one fish that was targeted) varied widely by species. As expected, patterns in success were very similar to those of catch rates. White bass anglers typically had higher success than other anglers, but sunfish anglers were successful over 60% of the time in 2003. White bass anglers likely have high success due to the abundance of the species and their schooling behavior, making them easier to catch. Success rate of "generalist" anglers was less than 38% throughout the study and is likely a reflection of their skill level. Nearly 18% of this group of anglers was under the age of 15, suggesting that many anglers in this group were with a family. Anglers specializing in largemouth bass tend to be highly skilled (Wilde and Ditton 1994), but were successful on less than 50% of their trips. This may be the best indicator of the difficult fishing conditions at Lake Pleasant. Finally, the low success of striped bass anglers may be a function of the new fishery; anglers do not yet know how to effectively fish for stripers.

Angler Satisfaction

Anglers were generally dissatisfied with their fishing experience at Lake Pleasant, with more than half indicating that they had a poor experience. This can be directly attributed to their success and catch rates. Anglers that were successful in catching at least one fish typically gave a rating of fair or better. Similarly, with increasing catch rates came a higher rating of the fishing experience.

Population Dynamics

Variations in species and size selectivity due to differences in behavior and distributions preclude the use of a single gear type for community-based sampling (Hayes 1983). Therefore, we used a combination of gill netting and electrofishing to describe the community composition and population characteristics of fish species in Lake Pleasant. Shifts in seasonal population dynamics inherently bias sampling data and must be taken into consideration. To reduce these biases, we sampled the same time each year, during both spring and fall, at randomly selected sites. It is also important to note that comparisons were not made between spring and fall samples, as many biases were eliminated by separating the data by season.

Species Composition

Percent composition was influenced by a high number of threadfin shad collected during Fall 2002 and Spring 2003-2004 samples. This is likely the result of large year classes in 2002 and 2003, and the timing of the sample (threadfin shad had moved to nearshore habitats in spring for spawning). Most other species decreased in percent composition due to the large number of shad collected. Golden shiner, red shiner, crappie, and tilapia were rare in the sample; red shiner were only collected during Fall 2000. The newest species to the reservoir, striped bass and flathead catfish, were only sporadically collected throughout the reservoir. However, striped bass may be underrepresented in our samples due to site location bias (gill nets were fished near shore, but striped bass are pelagic).

Relative Abundance

To obtain a more accurate estimate of relative abundance, CPUE was only calculated for species susceptible to a particular gear type (Murphy and Willis 1996). For example, largemouth bass are not effectively sampled using gill nets, so any largemouth bass caught in gill nets were disregarded. Similarly, pelagic species such as white bass were disregarded in the electrofishing catch.

Relative abundance of fishes in gill net samples in Fall 2002-2003 and Spring 2003-2004 was greatly influenced by extremely high catch rate of threadfin shad. Large schools swimming into a net can easily influence threadfin shad CPUE, but our sampling methods (large number of randomly selected sites) reduce the probability of these events impacting catch rates. Sammons and Bettoli (1998) found that larval production of threadfin shad increased significantly after a winterkill event because competition for food was reduced. Although it is unlikely that a winterkill occurred in Lake Pleasant, population size during the previous two years (2000 and 2001) may have been low enough (for unknown reasons) to prompt a successful spawn for shad in Spring 2002. Lifespan of threadfin shad is typically less than 2 years and most reach adult size (~105 mm) and spawn during their first year of growth (Carlander 1969). The large number of shad observed in Fall 2002 and Spring 2003 were likely a result of the strong year-class produced in Spring 2002. Catch rates of shad decreased again in Fall 2003 and Spring 2004, which indicates that the Spring 2003 year-class was not as strong as the previous year.

Sunfish catch rates also increased in Fall 2002-2003 and Spring 2003, which is likely due to a large 2001 year-class. The 2001 year-class may have been successful due to decreased competition from the low number of larval shad in previous years (e.g. Kim and DeVries 1998). Sunfish catch rates decreased again in 2004, possibly due to a successful shad spawn in 2002. Long-term data sets might reveal that relative abundance of the two populations is inversely related, but the effect of successful shad production on sunfish populations may not be observed for up to two years later (based on the above observations). Other factors that may negatively impact the sunfish population, regardless of shad abundance include a lack of quality habitat (cover), reservoir fluctuations which can affect spawning success and available cover, and predation (Ploskey 1986).

Relative abundance of white bass and striped bass have both increased during spring and decreased during fall. The increase of striped bass CPUE in spring is significant, as is the decrease of white bass in fall. The increase in striped bass CPUE in Fall 2003 was influenced by a large catch of age-0 (200-300 mm) fish. There has been no direct evidence of striped bass spawning in the reservoir, but the large number of fish from the Spring 2003 year-class makes it difficult to believe that all of those fish came from the CAP canal. The significant decrease in abundance of white bass in Spring 2004 is probably related to the lack of precipitation and runoff in 2002 and 2003, which may have resulted poor year-class strength.

Relative abundance of largemouth bass from electrofishing samples was highly variable throughout the study. McInerny and Degan (1993) found that electrofishing catch rates are an accurate indicator of population density, so the variation in our catch probably reflects actual fluctuations in the population. Upon closer examination, catch rates were highest in spring and Fall 2003, indicating that there may have been strong year-classes in both 2002 and 2003.

Although CPUE of crappie was low in all samples, catch rates increased in Fall 2003. Evaluation of larval trawls in the Agua Fria River during 2002 indicated that crappie spawned with some success (unpublished data). The low number of crappie in our samples is likely a function of low recruitment and gear avoidance. Trap nets are typically most effective for capturing crappie because they are a structure seeking species (Hubert 1996), but have proven ineffective in Lake Pleasant due to the morphology of the lake (unpublished data).

The differences in catch rates between basins were sporadic, and when there was a difference, the upper basin had higher catch rates. The upper basin has more suitable spawning areas for most species than the lower basin (personal observation) and may result in movement during spring. Not surprisingly, tilapia were primarily found in the upper basin; tilapia use vegetation extensively and there is more aquatic vegetation in coves in the upper basin than in the lower basin (personal observation).

Size Structure

Statisticians often warn against combining data from different gear types for analyses of size structure data and associated indices (Ricker 1975). However, since comparisons were made within the same water body rather than among water bodies, combining data from electrofishing and gill netting surveys should minimize the size biases associated with each gear type.

Mean length, PSD (and RSD) values, and the shape of length-frequency histograms can be influenced by unusually small or large year-classes (Guy and Willis 1991). Many species had lower mean lengths (and weights) during Fall 2003 and Spring 2004 than any other sampling period in Phase II. Close examination of length-frequency histograms and PSD values indicate that the decrease in mean size of species such as common carp and channel catfish may have been influenced by a large year-class of each species in Spring 2001. However, this strong year-class was not vulnerable to our sampling gear (gill nets) until Fall 2002, when a large number of age-2 fish were collected; Hubert (1996) reported that smaller fish sometimes will not push themselves into the mesh of gill nets. The large number of smaller fish skews the length-frequency histogram to the left, resulting in the decreased mean length.

White bass exhibit a bi-modal length-frequency distribution with the first peak appearing at age-0 in the fall. Slower growth of older individuals causes age classes to 'stack-up' in the second peak and individual year-classes are impossible to discern (DeVries and Frie 1996). Colvin (2002) concluded that fall gill net samples provided the best estimates of age- and size-structure. Based on the first mode, it appears that white bass had strong year-classes in 2002 and 2003, but a weak year-class in 2001. Spring 2001 was a year of high precipitation and runoff, causing the Agua Fria and other tributaries to flow, and should have resulted in favorable reproductive conditions for white bass. There are several possible explanations for the perception of a weak 2001 year-class: 1) there may have been successful reproduction, but low recruitment due to factors such as predation or competition; 2) there may have been very fast growth rates due to high lake productivity in 2001 and the year-class is included in the second peak of the histogram; or 3) we may have simply missed the year-class with our sampling gear.

Largemouth bass exhibited relatively weak year-classes in 2000 and 2001, but stronger in 2002 and 2003. The decreased mean lengths in 2003 and 2004 reflect the prevalence of those year-classes in the sample. PSD and RSD values for largemouth bass were within the targeted ranges for a balanced population until Spring 2004. The balanced range indicated that recruitment, growth, and mortality rates were stable (Anderson and Weithman 1978), however the low PSD in 2004 indicates smaller individuals now dominate that population. This could be a result of density-dependent interactions caused by catch-and-release angling (Perry et al. 1995).

Mean length of striped bass was largest in Spring 2003 and smallest in Fall 2003. As CPUE numbers indicate, there appeared to be a strong 2003 year-class, but again there has been no evidence of reproduction in the reservoir (larval tows in 2002 did not contain striped bass larvae and all adult striped bass collected in Spring 2003 were examined and found to be unspent with discolored gonads). Further studies will show exactly where these fish are spawning (Meding 2004). The low PSD and skewed RSD (towards smaller fish) observed for striped bass may be a function of sampling location and an inability to effectively capture large pelagic fishes with shoreline gill nets.

The few crappie collected in Lake Pleasant have a large mean length which resulted in high PSD values. RSD values for incremental length categories show that the population is dominated by a large number of preferred-memorable sized fish. This may be an indication of fast growth and low recruitment.

Finally, bluegill had a higher mean length and weight in Fall 2002 and Spring 2003. Length-frequency histograms indicate that bluegill probably had a strong year-class in summer 2001 and mean length has continued to increase as that year-class becomes older. Until Spring 2003, bluegill PSD was below the accepted range for a balanced population (Willis et al. 1993). The balanced population in Spring 2003 is likely a result of the strong 2001 year-class.

Relative weight (W_r) is an index of condition and gives an idea of the general health of a population (Bister et al. 2000). Because spring spawning may greatly influence the condition of fish (Pope and Willis 1996), we concentrate our discussion of relative weight on fall collections. Evaluating the W_r of incremental length groups ensures that nuances associated with length-related condition do not go undetected (Murphy et al. 1991). A W_r in the range of 95-105 is generally considered optimal.

Overall relative weight of common carp, channel catfish, and bluegill decreased steadily from 2000 to 2003. The decrease in carp W_r is most evident in the largest length categories (preferred–memorable, and memorable-trophy). Porath and Peters (1997) found that length-group assessment of W_r was an effective way of detecting prey deficiencies in reservoirs. However, Liao et al. (1995) believed that W_r is only a good predictor of prey availability when diets are relatively narrow. Carp are generalists and feed primarily near the bottom on a wide variety of organisms including, insects, crustaceans, annelids, mollusks, fish eggs, fish remains, and plant tubers and seeds (Lammens and Hoogenboezem 1991, Moyle 1976). Channel catfish condition follows a similar pattern, and their diet is equally diverse (Siegwarth and Johnson 1998). Therefore, the decrease in condition of larger fish is likely not prey related. Relative abundance of either species did not increase appreciably throughout the study, so it is also unlikely that the decrease in condition was density dependent. DiCenzo et al. (1996) found that relative weight varied with the trophic status of reservoirs. Accordingly, it may be reasonable to assume that carp and catfish (as well as other species) condition may fluctuate in relation to the productivity of Lake Pleasant. However, for these two species, W_r for all length categories is at or near the optimal range and there may not be a problem, as long as the trend does not continue.

Conversely, bluegill W_r is generally higher for larger fish, but is below optimal levels for all length categories. The low condition, especially for smaller sunfish, suggests limited prey availability and may be a result of competition with threadfin shad for zooplankton (DeVries et al. 1991).

Relative weights of largemouth bass and striped bass are below the optimal level for most length categories throughout the study. This suggests that prey availability (especially threadfin shad and sunfish) may be limiting (Liao et al. 1995). Diet data that indicates largemouth bass (a piscivore) are feeding primarily on crayfish and insects may be further evidence of limited threadfin shad availability (Allen et al. 1999). White bass also prey heavily on threadfin shad (Harper and Namminga 1986), but their relative weight is at or near the optimal range for most length categories. Striped bass and white bass habitat use typically overlaps and some degree of competition may be expected, however white bass tend to occupy different niches than largemouth bass and competition for food resources is much less likely (Kohler et al. 1986). Regardless, the divergent condition of the three species suggests that the abundant white bass population may outcompete striped bass and largemouth bass for a limited threadfin shad resource (Matthews et al. 1992).

Aging, Food Habits, and Fish Health

Otoliths proved very difficult to read, especially for larger fish. Due to the difficulty in reading the otoliths, we were unable to identify year-class strength for the three species. However, we were able to back-calculate lengths with some degree of confidence. As predicted, white bass and striped bass growth during the first three years was among the highest in the nation (Carlander 1997).

Examination of food habit data for largemouth bass indicates that bass are not primarily piscivorous in Lake Pleasant. Crayfish and insects make up a majority of the largemouth bass diet. However, the mean length of the fish analyzed was 274 mm; larger fish may rely more heavily on threadfin shad and sunfish. White bass primarily consume threadfin shad, but they also prey upon crayfish and insects in Lake Pleasant. Consumption of invertebrates indicates that shad limitations may occur at certain periods or in particular locations of the lake.

Largemouth Bass Virus (LMBV) is one of more than 100 naturally occurring viruses that affect fish but not warm-blooded animals. It is related to a virus found in frogs and other amphibians and nearly identical to a virus isolated in fish imported to the U.S. for the aquarium trade. LMBV has been found in bass that show no signs of disease, which suggests that some fish might be infected but not ever become ill. The virus appears to attack the swim bladder, causing bass to lose their balance. Most kills occur from June through September, suggesting that warmwater temperatures might be a factor (Texas Parks and Wildlife Report). Sixty fish were analyzed from Lake Pleasant and all tested negative for the virus, as well as a variety of other fish pathogens and viruses. Arizona Game and Fish will continue to monitor the population every 2-3 years.

Water Quality – Phase II

The combination of phosphorous levels (not detected), secchi depth measurements, and chlorophyll-a levels indicate that Lake Pleasant is a mesotrophic reservoir during spring months (February-June) and an oligotrophic reservoir throughout the rest of the year (Taylor et al. 1980). These trophic state designations coincide with the annual drawdown and refilling of Lake Pleasant with CAP canal water (from the Colorado River) and spring runoff from the Agua Fria River and other tributaries.

There were no remarkable trends concerning the temperature, dissolved oxygen, pH, or conductivity of the reservoir. The thermocline developed in April-May each year and dissipated in October-November, generally at the same depths each year. During the remainder of the year, the water was essentially of constant density, and wind and wave action mixed the water thoroughly from top to bottom. During late summer, dissolved oxygen concentration in the hypolimnion was uninhabitable for fish species (Knights et al. 1985). There is considerable speculation that if the right conditions exist (temperature > 25^{o}C and dissolved oxygen < 2.0 mg/L), striped bass may fall victim to a temperature-oxygen "squeeze" (Axon and Whitehurst 1985; Coutant 1985) and the population may be naturally controlled. We did not observe these conditions in the reservoir during Phase II, although several large adult striped bass have been found floating on the surface (personal communication with anglers).

Chlorophyll levels were generally low in Lake Pleasant (Taylor et al. 1980). Positive relationships between chlorophyll levels and

Agua Fria inflow indicate that the river inflow may have more influence over productivity than the canal, even though the majority of water enters the lake through the canal. This suggests that water entering Lake Pleasant from the canal was nutrient poor. However, Walker (1998) found that nutrients in the canal closest to Lake Pleasant were substantially higher than those found in the lake itself. Specifically, total phosphorous and orthophosphates were very high in 1996 (0.27 mg/L and 0.16 mg/L, respectively) and remained relatively high in 1997 (0.09 mg/L and 0.05 mg/L, respectively). Therefore, nutrients entering the reservoir from the canal are probably trapped in a nutrient sink near the dam, possibly because the old dam is still in place and acts as a "baffle". Decreased productivity may have a significant impact on the population structure and health of sport fish populations (Maceina and Bayne 2001).

The majority of metals, ions, and nutrients were undetectable throughout the study, and those that were detectable were all within EPA standards (Thurston et al. 1979).

DISCUSSION – PHASE COMPARISON

Due to the extremely high number of samples (including angler surveys) collected in both Phase I and Phase II, nearly all comparisons between the two phases were statistically significant. However, when evaluating the results of the study, it is important to remember that statistical significance and biological significance are not always synonymous (Tacha et al. 1982; Yoccoz 1991). That is, differences that are biologically irrelevant may be statistically significant and vice versa (Johnson 1995). This becomes a challenge because an error in interpreting the population status of any species in Lake Pleasant may ultimately affect management decisions. If a species population is determined to be in decline, when in fact it is robust or exhibiting natural fluctuations, mitigation measures might waste resources, cause a loss of credibility, and compromise the potential for future management efforts (Blaustein et al. 1994).

Our challenge is to determine which of these comparisons constitutes a biologically significant change. However, determining what is "biologically significant" is a difficult obstacle and does not have an easy solution (Greenwood et al. 1994; Pechmann and Wilbur 1994; Reed 1996; Reed and Blaustein 1997; Hayes and Steidl 1997). Any population decline can be considered biologically significant if it continues unabated (Reed and Blaustein 1997). On the other hand, a population may decrease substantially in one year, but increase by the same magnitude the following year. As shown above, many fish species show this cyclic trend in population status, typically due to environmental conditions, but the rapid increases and declines cannot be considered biologically significant. Still, an increasing or decreasing population size of a given species, of any magnitude, ultimately has some effect on the ecosystem.

We established, *a priori,* acceptable levels of detectable change based on budgetary and time constraints. In all cases we achieved the statistical power to detect that change. Therefore in our discussion of the results, we not only consider the statistical differences, but also the percent change detected between the two phases. Ultimately, it is the managers' decision as to whether differences in the data constitute a biological change; our results, and our discussion of the results, gives them the necessary information to make that decision.

Angler Surveys

The total number of interviews conducted in Phase I of the study was excessive; the power to determine if the actual mean CPUE was different than the expected mean was 100%. In planning Phase II, we scaled down the number of angler surveys so that we had 80% power to correctly predict at least a 20% decrease in mean CPUE ($P < 0.05$). However, when all surveys were complete, we had enough interviews between the two phases to correctly detect at least an 8% decrease with 80% power (or a decrease of at least 14% with 100% power; SamplePower 2.0, SPSS).

The proportion of shore anglers decreased by 55% from Phase I to Phase II. Shorelines were more accessible and not as steep prior to creation of the larger lake, so more anglers had the opportunity to fish from shore. In addition, 42% of shore anglers were successful in Phase I, compared to only 24% in Phase II.

The proportion of youth anglers differed by less than 3% between the two phases. It is somewhat surprising that the difference was that low and that it was a decrease from Phase I to Phase II because youth (ages 12-17) participation in angling increased by 10.9% nationwide during the 1990's (USDI 2001). However, Lake Pleasant is somewhat remote (at least five miles from the nearest populous), the lake can be intimidating because of its size, there are limited shore fishing opportunities, and there is an entry fee at all gates. These factors likely contribute to the low use by youth anglers.

Angler Preferences

Anglers fishing Lake Pleasant have become more specialized over the past 15 years. In Phase I, 47% of anglers were "generalist anglers" and did not target a specific species, compared to 34% in Phase II. The decrease in generalist anglers might be attributed to the increase in fishing clubs and competitions that target a single species (e.g. black bass clubs and tournaments). Like most other warmwater reservoirs in the United States (Wilde and Ditton 1994), largemouth bass was the most popular species targeted in Lake Pleasant during both phases; 33% of anglers in Phase I and 48% of anglers in Phase II. Even with the high abundance of white bass and the success of white bass anglers, few anglers (<10%) targeted the species in either phase. Despite the rising popularity of white bass in midwestern states (Guy et al. 2002), they have yet to catch on in the Southwest. The low level of interest may be due to their limitation in growth potential (i.e. maximum size of white bass is approximately 470 mm and 1,380 g in Lake Pleasant), or because of the high level of specialization for largemouth bass.

Angling Pressure

Anglers fished nearly 15% longer in Phase II than in Phase I. The increased size of the reservoir (i.e. takes longer to travel among fishing locations on the lake), the lower success rates (i.e. fish longer to catch a fish), and fewer shore anglers (i.e. fishing day for shore anglers is typically shorter than for a boater) may be influencing the time anglers are spending on the water.

Maricopa County Parks (MCP) provided Morgensen (1990) with an estimate of nearly 900,000 visitors per year in Phase I. In Phase II, visitor information provided by MCP and Maricopa Water District estimated 845,000 visitors per year. We find it difficult to believe that the number of visitors has decreased when the size of the park and lake have increased three-fold. No data was available from Maricopa County to corroborate the numbers reported in Morgensen (1990); they dispose of data after five years. Based on random daily angler counts conducted in Phase I and extrapolation to estimates for the entire year, we found that the total number of visitors was closer to 176,000 per year. This number would seem more realistic, but probably is still not accurate.

Similarly, the estimate of over 416,000 anglers using the lake in Phase I was 62.5 percent higher than in Phase II; a number we do not believe to be correct. Again, extrapolation from actual entry counts in Phase I provides an estimate of just over 96,500 anglers per year. Due to the discrepancy in data, it is probably not prudent to comment on the comparison of visitors or anglers between the two phases.

We were able to make comparisons of angling effort based on data collected through the interview process. However, counts were not conducted in association with roving surveys during Phase I, so estimates of pressure only include data from exit interviews for both phases. Therefore, the estimates are considered to be conservative because they do not count anglers that used "off-road" access points or boat ramps, or anglers that accessed the Agua Fria River from the north end of the reservoir during the period of the eagle closure (December 15 – June 15). In fact, the estimate used for comparison in Phase II is likely more conservative than the Phase I estimate because exit interviews were conducted from boat ramps and shore anglers were not well represented. In Phase I, even shore anglers had to pass through the only exit gate in the park, so there was a better opportunity to ensure that a majority of anglers were interviewed.

Regardless of the difficulty in calculating an accurate estimate of effort, total angling pressure on Lake Pleasant increased in Phase II. Conversely, the proportion of anglers entering the park decreased in Phase II, which is a result of the increase in recreational boaters, jet skis, and day-use visitors.

Angler Catch and Harvest

In the 1980's, the total ratio estimate was the method in which CPUE was calculated in the State of Arizona. Unfortunately though, creel surveys are no longer conducted on a regular basis in the State. We provided a total ratio estimate simply to compare current conditions to those past surveys. Statistical tests could not be performed because there is no variance associated with the estimates. The total ratio estimate in Lake Pleasant during Phase I (0.39 fish/h) was slightly higher than the statewide median of 0.38 fish/h, and Phase II was slightly lower (0.34 fish/h). It is interesting to note, however, that most values fall below the statewide goal of 0.40 fish/h or two fish per day (AGFD 1990).

The more accurate mean of ratios estimate shows an even larger disparity between overall CPUE in Phase I and Phase II. The decrease of 18.3% between phases not only represents a statistically significant decrease, but likely a sociological effect as well. For example, during Phase I an angler could expect to catch two fish per day (4.75 h), but an angler fishing in Phase II would need to fish nearly a full hour longer (5.71 h) to catch two fish in a day.

Mean catch rate for shore anglers in Phase I was nearly twice that of shore anglers in Phase II. The difference is due to variety of factors, but primarily the steep shorelines and lack of cover have probably contributed to the decline. Also, abundance of species that are more susceptible to shore anglers (e.g. sunfish and crappie) has decreased substantially from Phase I to Phase II.

Although overall catch rates decreased in Phase II, catch rates of largemouth bass and white bass (when targeted) increased in Phase II. A frequent complaint by anglers is that largemouth bass angling has declined since the "good ol' days". Although anglers are probably not as successful as in the years immediately following the trophic upsurge of the new lake (personal communication with anglers), our data indicate that fishing for largemouth bass is actually better now than it was 15 years ago. The decrease in overall catch rates between phases can be attributed primarily to a large decrease in sunfish catch rates, but also to decreases in catfish, crappie, and multiple species catch rates. These are all cover seeking species whose abundance is likely suffering from the lack of cover in the reservoir.

It is interesting to note that catch rates for anglers not targeting any one species (generalists) are higher than catch rates of specialists targeting largemouth bass. Generalists are typically considered to be somewhat naïve to fishing techniques and hold a more simplistic view of the sport (Bryan 1977). In contrast, the specialized anglers are typically more skilled, hold themselves in high regard, and have made fishing a central life interest (Bryan 1977).

The advent of catch-and-release fishing (Barnhart 1989) is evident in the comparison of harvest rates between Phases. It is especially evident in largemouth bass harvest, as nearly half the largemouth caught in Phase I were harvested, and only 18% were harvested in Phase II.

Whole lake estimates of catch and harvest are considered to be conservative for the same reasons as estimates of effort. Nonetheless, catch of largemouth bass and white bass was over twice as high in Phase II, whereas catch and harvest of sunfish was nearly eight times higher in Phase I. The differences in catch and harvest between the two phases, and the shift in angler preferences supports the speculation that anglers using Lake Pleasant have become more specialized.

Angler Success

Even though CPUE varied significantly between phases, the success rate of anglers (angler catching at least one fish) did not differ and was just under 50% for both phases. Most anglers (75%) believe that it is important to catch at least one fish on their fishing trip (Connelly et al. 2001). So, with the opportunity to catch a fish being no better than a "flip-of-the-coin", it is not surprising that angler satisfaction is low.

For targeted species, success was even lower, except in the case of sunfish anglers in Phase I and white bass anglers in Phase II. Anglers targeting largemouth bass had a dismal success rate of less than 37% in Phase I and just under 47% in Phase II. Relative abundance does not appear to be unusually low for species such as largemouth bass, white bass, and catfish, so the low catch rates and low success must be a factor of difficult fishing conditions in the reservoir [e.g. deep water, lack of habitat, fish that have been conditioned to avoid artificial lures (Garrett 2002)].

Angler Satisfaction

Although fewer anglers rated their fishing experience as "poor" in Phase II than in Phase I, the mean satisfaction rating was below "fair" in both phases. Satisfaction can be related to many factors, including aesthetics, weather, quality of amenities, and fishing success (Spencer and Spangler 1992). We attempted to limit satisfaction to a question of fishing success, but anglers interpret questions in many different ways. One additional factor that affects satisfaction ratings is the expectation of catch, and oftentimes angler expectations are unrealistic. They are typically related to personal standards and can vary considerably among anglers (Weithmann and Katti 1979). As expected, satisfaction at Lake Pleasant was directly related to CPUE (i.e. anglers are happier when they are catching fish).

Population Dynamics

Due to the high variability in gill net and electrofishing samples, it was difficult to obtain adequate statistical power for making meaningful comparisons. Given our manpower and budgetary constraints, we planned for 80% power to correctly identify at least a 30% change ($P < 0.10$) in mean CPUE for gill net surveys and at least a 50% change with 80% power for electrofishing CPUE. The decrease in electrofishing CPUE was so large that our actual power was 100%, but for gill netting surveys, power was only 6% in spring and 82% in fall.

Species Composition

Yellow bullhead, goldfish, Sonora sucker and mosquitofish were collected in Phase I, but not in Phase II. The goldfish collected in Phase I was likely an aquarium release from the public. The Sonora sucker may have entered the reservoir during a flood in the early 1980's and persisted. Mosquitofish may have been present in Phase II, but likely so rare that we did not collect any in electrofishing samples. The reason for their disappearance in Phase II is unknown.

Striped bass and flathead catfish entered the reservoir via the CAP canal system from Lake Havasu, so they were not collected in Lake Pleasant in Phase I. The EIS (USDI 1984) warned of new species entering the reservoir through the canal system, but prevention measures (e.g. gates, electrical fields) were not taken to keep them out of the reservoir.

Relative Abundance

Relative abundance of fish susceptible to gill nets was higher in Phase II than in the first phase. Since spring gill netting had such high variability (and subsequently low power), fall CPUE is likely more indicative of the true relative abundance. In Phase I, white bass and common carp dominated gill net catches, while in Phase II white bass and threadfin shad dominated the catch. Since the same mesh sizes were used in each of the phases, it is difficult to determine why threadfin shad were underrepresented in gill net catches during Phase I, especially since their abundance was so high in electrofishing samples. It may be possible, that threadfin were not encountered simply by chance, since fewer gill nets were set during Phase I, and the probability of encountering shad schools is low .

For electrofishing samples, relative abundance in Phase I was five (fall) to eight (spring) times higher than in Phase II. Overall relative abundance in Phase I was influenced by extremely high catch rates of threadfin shad and sunfish. However, since there was no statistical difference in threadfin shad abundance between phases, it is likely that high catch rates were influenced by a few sites where large schools of shad were "herded" into a cove and electrofished. The significant differences in relative abundance of sunfish, largemouth bass, carp, and crappie during both spring and fall indicate that those populations have decreased over the 15-year period.

Size Structure

As expected, mean length and weight varied seasonally for each species. It is impossible to draw meaningful conclusions when a species, such as largemouth bass, is significantly larger in one phase during fall, but larger in the other phase during spring. Seasonal differences in cases such as this are more than likely related to spawning and the timing of the sample. Evaluation of PSD is representative of the entire size structure of the population, and generally holds true regardless of season.

Sunfish PSD was generally low in both phases. However, Willis et al. (1993) provided objective ranges for a balanced bass-bluegill community structure, and PSD values in both Phase I and Phase II are at or near the balanced range for both species. This indicates that rates of recruitment, growth, and mortality are satisfactory (Anderson and Weithman 1978). In both phases, PSD of carp, crappie, and white bass were very high, which could be an indicator of fast growth rates, but in the case of crappie, could also be an indicator of poor recruitment

PSD of channel catfish was significantly higher in Phase II and is indicative of a population dominated by large individuals. In Phase I, the size structure was skewed towards smaller fish. This suggests that there may have been a strong year class during Phase I that influenced the size structure. High PSD in Phase II indicates that growth rates were high for channel catfish.

Spawning can greatly influence condition, but high or low values at any season could be an indicator of a problem and management opportunity (Anderson and Neumann 1996). In fall, sunfish and largemouth bass W_r were below the optimal range (95-105) during both phases.

In spring, only largemouth bass and redear sunfish were below the optimal range.

As described in our discussion of Phase II results, the low condition of largemouth bass indicates that their prey resources may be limited resulting in competition with other predatory species. White bass condition was optimal (Phase I) or near optimal (Phase II), and may indicate that they outcompete largemouth bass for prey resources. In addition, the low condition of sunfish species suggests limited prey availability and may be a result of competition with threadfin shad for zooplankton.

Water Quality

When Lake Pleasant became a regulatory storage unit for Lake Pleasant, the pattern of water level fluctuations changed dramatically. During Phase I, the reservoir fluctuated by less than 4 m throughout the year. It reached its highest point in March as inflow from runoff was at its peak, and reached its lowest point in July, at the height of the irrigation season. During Phase II, the reservoir fluctuated an average of nearly 21 m, as water was pumped in for storage and released to supply the city of Phoenix with water.

Despite the change in size of the reservoir, surface water temperature remained unchanged in both Phases. However, conductivity, dissolved oxygen, and pH were all higher in Phase II. Conductivity is a measure of resistance of a solution to electrical flow, and is thus an indirect measure of salinity in the water (Wetzel 1975). Water entering the reservoir from the CAP canal system comes directly from Lake Havasu (Colorado River). Therefore, the high conductivity measured in Phase II (compared to Phase I) is due to high salinity of Colorado River water entering the reservoir (AGFD unpublished data). There is also a direct correlation between pH and conductivity (Wetzel 1975), which is evident in the higher pH measurements in Phase II.

Although dissolved oxygen (DO) is higher in Phase II, it follows a similar pattern in both phases. The higher DO in Phase II is primarily due to measurements in March and September, both months in which chlorophyll levels were relatively high. Active photosynthesis during this period increased the oxygen levels.

In Phase I, the reservoir was considered to be a meso-eutrophic reservoir (based on chlorophyll, phosphorous, and secchi measurements). The transformation to a meso-oligotrophic reservoir in Phase II is not surprising with the decrease in nutrient concentrations (primarily phosphorous and orthophosphates) that came with the new source (CAP) of water (Maceina and Bayne 2001). Chlorophyll measurements decreased by nearly 1 mg/L in Phase II and as a result, mean secchi depth was nearly 3 m deeper in Phase II than in Phase I.

The increase in major ions in Lake Pleasant during Phase II is a direct result of the change in primary water source, from the Agua Fria River to the CAP Canal (Colorado River). The increase in ions is also reflected in the high conductivity measured in Phase II. Although ion concentrations have increased, current levels do not directly impact the fishery. However, algae distributions may be affected by the concentration of calcium and other ions (Wetzel 1975). Depressed levels of total phosphorous and orthophosphates (from Phase I) will likely temper any positive effects as a result of increased ions.

MITIGATION SUGGESTIONS

The impetus behind the current study was to determine if the completion of New Waddell Dam and subsequent filling of Lake Pleasant had caused a biologically significant impact to the fishery or the limnology of the reservoir. If a biologically significant *negative* impact was found, then mitigation actions must be considered.

Lake Productivity

The decrease in lake productivity may ultimately have the largest biological impact because the entire food web is impacted (Kitchell 1992). Case histories reviewed by Ney (1996) show that the reversal of the eutrophication process can have deleterious effects on reservoir fisheries, primarily due to the phosphorous-fishery relationship. Lake Pleasant is unique in that the majority of water enters and exits the reservoir at the same location. Because the majority of water now comes from the CAP canal (rather than the Agua Fria River), nutrient loading has changed significantly, causing the reservoir to go from a meso-eutrophic system in Phase I to a meso-oligotrophic system in Phase II. Although Colorado River water in the CAP canal is relatively nutrient rich (Walker 1998), total phosphorous, orthophosphates, and nitrogen were virtually undetectable in the epilimnion of the reservoir. However, Walker (1998) found much higher nutrient levels in the reservoir's hypolimnion. This indicates that nutrients are being trapped in the hypolimnion when the thermocline forms. Further, the original dam was left intact and may act as a baffle, creating a nutrient sink in the area around the intake/outlet structures. This prevents nutrients and sediments from being shared with the rest of the reservoir. Lastly, nutrients coming in with spring runoff are likely trapped in the hypolimnion at the north end of the reservoir.

The effect of decreased nutrients to the fishery starts at the bottom of the food web. Lake plankton communities are regulated by the resources available to them (Vanni et al. 1992). When nutrients such as nitrogen and phosphorous are limiting, phytoplankton and zooplankton density and community structure are adversely affected. The primary prey fish for predators in Lake Pleasant, threadfin shad, rely on zooplankton (and water temperature above 24^{o}C) for growth and survival (Betsill and Van Den Avyle 1997). So, when zooplankton abundance is low, threadfin shad are negatively impacted, and competition among the top-predators (e.g. striped bass, white bass, largemouth bass, and crappie) results.

Unless something is done to increase the nutrient load in the epilimnion of Lake Pleasant, zooplankton densities will generally be low with periodic spikes when productivity increases (usually correspondent to spring inflow) or when there is turnover. If these spikes occur when threadfin shad are hatching and temperatures are optimal (Betsill and Van Den Avyle 1997), then the shad will thrive and the effect will be realized up the food web. If productivity is low when shad are hatching, then cohort success will be low and competition will limit the predators at the top of the food web.

Options for increasing productivity in the epilimnion are limited and relatively expensive. Since the old dam appears to be acting as a baffle and trapping nutrients, removing it or moving the intake/outlet structures to a central lake location *may* increase productivity lakewide. However, nutrients would still be trapped in the hypolimnion when the thermocline forms and would be unavailable for fish production at the most critical time (just after the spawn). Aeration devices may help mix the reservoir during critical periods, but at an extremely high cost (Arlo 1973) with a low chance of success (Larry Riley, AZGFD, personal communication). Large-scale fertilization of reservoirs to increase productivity has been successful in some cases

(Budy et al. 1998), but is cost-prohibitive and has limited management applications (Vaux et al. 1995, Axler et al. 1988, Buynak et al. 2001). Finally, manipulation of water-levels combined with seeding shorelines to encourage macrophyte growth has potential for increasing nutrients (see references within Ploskey 1986), however it would require that CAP draws down water for an extended period and significantly alter their current drawdown schedule.

Mitigation Suggestion 1
Increase Productivity

Mitigation to increase nutrient loading in the reservoir is cost prohibitive with a low likelihood of success for increasing fish productivity. Although alternatives for increasing productivity should be explored, we do not suggest immediate mitigation actions.

Artificial Structure

While water level fluctuations can have positive impacts on fisheries (Sammons and Bettoli 2000), drastic fluctuations can act as a disturbance to the landscape, as littoral fish habitats are disrupted (Irwin and Noble 1996). Lake Pleasant is an extreme case of water level fluctuations, averaging over 21 m per year. Studies have shown that rapid and severe water level fluctuations can negatively impact predator behavior (Rogers and Bergersen 1995), spawning success (Bruno et al. 1990; Kohler et al. 1993), and recruitment (Maciena and Bettoli 1998). However, one of the lesser-understood impacts of water level fluctuations is the impact to habitat and cover. Dibble (1993) and Beauchamp et al. (1994) found that declining water levels exposed a large percentage of boulder and gravel substrates that supported high densities of small-bodied fishes, which likely led to declining populations. Water level fluctuations also have a tendency to erode shorelines, redistribute sediments, and weaken timber to a point where it is uprooted by wave action (Ploskey 1986).

Although we did not collect data that quantifies the impact of water level fluctuations in Lake Pleasant, it is evident by the barren shorelines (especially on the western side of the lake) that the initial clearing of vegetation (USDI 1984) and drastic water level fluctuations over the past 15 years have impacted habitat. We believe that these impacts to the habitat and cover have been a factor in the observed decline of largemouth bass, sunfish, and crappie populations.

The Bureau of Reclamation is committed to holding water levels nearly constant during March and the first part of April to preserve suitable spawning conditions for largemouth bass (USDI 1984). However, length-frequency histograms for largemouth bass caught in fall indicate that spawning likely occurs into early summer (perhaps as late as July). Drawdown beginning in mid-April has the potential to affect gravel habitats used by largemouth bass for spawning (Dibble 1993), and is a primary factor regulating the distribution and abundance of age-0 largemouth bass (Irwin and Noble 1996). In addition, sunfish spawning typically occurs at warmer water temperatures than largemouth bass (Carlander 1977), so early drawdown may also have severe impacts on their spawning success. However, as previously noted, the CAP drawdown schedule would need to be severely altered to protect largemouth bass and sunfish spawning and rearing habitats throughout the spawning season.

Sunfishes are structure-seeking fish whose populations are adversely impacted by the lack of cover in Lake Pleasant. Sunfishes use cover for foraging and to avoid predation (Savino and Stein 1982). Due to the lack of cover in Lake Pleasant, sunfish are left in the open, vulnerable to predation. In addition, growth (and subsequently condition) is impacted due to a lack of insects and other food items as a result of water level fluctuations (Eschmeyer 1948; Tomcko and Pierce 2001).

Crappie and largemouth bass are also impacted by the lack of structure in the new reservoir. Crappie use cover for spawning (Beam 1983) and feeding (Markham et al. 1991), however density doesn't appear to be completely dependent upon macrophyte abundance (Allen et al. 1998). Conversely, age-0 largemouth bass abundance and survival has been positively related to percent coverage of aquatic macrophytes (Miranda and Pugh 1997; Tate et al. 2003). In addition, adult largemouth bass use cover (to an extent) to employ certain predation tactics, as prey fish are more concentrated in vegetated areas (Hayse and Wissing 1996).

The use of artificial structures to enhance fish habitat in reservoirs has been widely used, but with varying degrees of success (Allen et al. 2003; Wills et al. 2004). Success is especially limiting in reservoirs with drastic fluctuations in water levels, like Lake Pleasant. However, experimental floating structures used in Elephant Butte, NM have had good success in providing cover for sunfishes and increasing growth of fishes by increasing insect abundance (Casey Harthorn, New Mexico Game and Fish Department, personal communication). These structures work on a series of cables that move up and down with changing water levels and include the use of live vegetation.

Mitigation Suggestion 2
Artificial Structure

Increase available cover in Lake Pleasant through the addition of multiple artificial structures. The structures should be designed in a manner in which they are able to move with water level fluctuations. They should also include live vegetation with artificial substrate, which allow growth both above and below the water surface.

Monitor Angler CPUE

Largemouth bass abundance has decreased since Phase I, but angler success and CPUE has increased. Abundance is likely lower due to the water level fluctuations, a situation with no easy solution (due to water demands). Supplemental stocking of largemouth bass would likely reduce the quality of the fishery as additional demands are put on the prey base. Food habits of largemouth bass indicate that crayfish is their primary prey item. This indicates that threadfin shad and sunfish (prey fish) are limiting in the system. Condition of striped bass, white bass, and largemouth bass is already below the optimal range and additional predators would only exacerbate the problem. The idea of creating a closed season to protect spawning bass is an interesting management tool (Kubacki et al. 2002), but the Agua Fria closure from December through June already creates a "sanctuary" for spawning bass (Suski et al. 2002).

Angler catch and success for largemouth bass has likely increased due to the specialization of anglers, as knowledge and equipment continue to improve. However, with closer examination of data collected in Phase II, we see a continual steady decline in angler CPUE (of largemouth bass). It is possible that the bass population has not stabilized and we are at the tail end of the trophic upsurge. CPUE for largemouth bass (and other species) may continue to decline for several more years to a point that is equal to or lower than levels observed in Phase I.

Mitigation Suggestion 3
Continue to Monitor Angler CPUE

Largemouth bass population abundance has decreased since Phase I, but the effect is somewhat tempered by increased angler catch rates. However, the steady decline in angler CPUE for largemouth bass in Phase II is cause for concern. At this time, mitigation to enhance the largemouth bass population may be premature. Therefore, the recommendation is to continue monitoring angler CPUE in Lake Pleasant. Mitigation to enhance the largemouth bass population should be considered if the trend continues.

Striped Bass Suppression

It is likely that striped bass initially entered the CAP and subsequently Lake Pleasant as eggs or larvae, entrained in Colorado River water pumped from Lake Havasu. At this point, we have not been able to determine if reproduction is occurring within the reservoir itself. Length-frequency histograms and locations of capture (of age-0 fish) indicate that they probably are spawning in Lake Pleasant. However, the population is relatively low, so the impact to existing populations of sportfish and prey fish is not fully understood.

Lake Pleasant anglers are concerned that the striped bass population has become established, and will eventually out compete the favored largemouth bass and white bass fisheries by effectively eliminating the primary prey source, threadfin shad. Studies in Lake Mead and Lake Powell have shown that striped bass will, in fact, dominate a reservoir after introduction (Allen and Roden 1978; Baker and Paulson 1983). We have already seen a decrease in white bass condition, likely as a result of competition with striped bass.

Mitigation Suggestion 4
Striped Bass Suppression

Currently, AZGFD is conducting additional research to determine reproductive potential, habitat use, population abundance, and bioenergetics of striped bass in Lake Pleasant (Meding 2004). The decreased condition of white bass may be one of the first indicators that striped bass will have an effect on the fishery. Should the results of the study definitively indicate that striped bass are impacting the fishery, then mitigation to reduce or remove the population must be considered.

MANAGEMENT RECOMMENDATIONS

In addition to mitigation recommendations, AZGFD managers should consider some recommendations for management of the reservoir.

1. Continue to monitor angler CPUE to determine if Mitigation Suggestion 3 is warranted.

2. Because Lake Pleasant is one of the heaviest used fisheries in the state, it is extremely important to monitor the fish populations on a regular basis. Procedures outlined in the AZGFD Standard Fish Sampling Protocol (Bryan 2004) should be used to establish a long-term monitoring program.

3. Many anglers have suggested that a slot-limit is needed on Lake Pleasant to improve the size structure of the largemouth bass population. Regulations such as minimum or maximum length limits and slot limits only work as management tools if anglers harvest fish. Only 18% of largemouth bass are currently harvested in Lake Pleasant, so any regulations

would have no biological effect on the population. However, managers should weigh the pros and cons of the sociological effects that may result.

4. There may be many factors contributing to the decline of the largemouth bass fishery (as noted above). However, anglers have found that "bed-fishing" (or "sight-fishing") is an easy way to catch largemouth bass in the spring (and may be the reason for higher catch rates in Phase II). Several studies have determined that this practice has the potential to negatively impact largemouth bass populations (Suski and Philipp 2004; Ostrand et al. 2004). Conversely, some studies claim that there can be very little impact (Philipp et al. 1997). Researchers and managers should look more intensively at this practice and determine the effects of bed fishing on reproductive success in Lake Pleasant.

5. There are an estimated 150 largemouth bass tournaments per year on Lake Pleasant (unpublished data). Many of these are held during summer months when mortality is near 67% (Bryan *in prep*). Tournaments at Lake Pleasant should be regulated to reduce pressure and eliminated in summer months to reduce angler-induced mortality.

6. Less than 10% of anglers target white bass at Lake Pleasant, yet angler success and CPUE are higher for white bass than any other species. Additionally, white bass are the most abundant sportfish in the reservoir. Managers should promote the white bass fishery to better utilize the resource.

7. Similarly, the striped bass population appears to be expanding and should be better used as a resource. Promoting anglers to fish for and harvest striped bass would help control numbers so that the fishery can be managed.

8. The number of shore anglers using the lake has decreased since Phase I. Addition of fishing piers may make Lake Pleasant more attractive to shore anglers and family anglers.

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APPENDICES

Appendix 1a. Estimated angler use probabilities assigned to various strata to determine number of days to sample (angler surveys) in each stratum during 2001. All estimates were derived from the expert opinion of lake managers and park supervisors.

Sampling Period	Seasonal	Weekday	Weekend-Holiday	Time Period	Total Probability	Number of Days
Access Point Surveys						
Winter (Jan 1 – May 30; Nov 1 – Dec 31)	0.40					
12a – 6a		0.40		0.05	0.008	0
			0.60	0.05	0.012	1
6a – 12p		0.50		0.40	0.080	5
			0.50	0.40	0.080	5
12p – 6p		0.50		0.35	0.070	4
			0.50	0.35	0.070	4
6p – 12a		0.40		0.20	0.032	2
			0.60	0.20	0.048	3
Summer (Jun 1 – Oct 31)	0.60					
12a – 6a		0.40		0.05	0.012	1
			0.60	0.05	0.018	1
6a – 12p		0.40		0.40	0.096	5
			0.60	0.40	0.144	8
12p – 6p		0.50		0.25	0.075	4
			0.50	0.25	0.075	4
6p – 12a		0.50		0.30	0.090	5
			0.50	0.30	0.090	5
Total Days for Access Point Surveys						57
Roving Agua Fria Surveys						
Closure (Dec 15 – Mar 01)	0.2					
6a - 12p		0.4		0.5	0.040	0
			0.6	0.5	0.060	0
12p – 6a		0.4		0.5	0.040	0
			0.6	0.5	0.060	0
Closure (Mar 01 – Jun 01)	0.8					
6a - 12p		0.4		0.5	0.160	1
			0.6	0.5	0.240	1
12p – 6a		0.4		0.5	0.160	1
			0.6	0.5	0.240	1
Total Days for Roving Agua Fria Surveys						4
Roving Shoreline Surveys						
Winter (Jan 1 – May 30; Nov 1 – Dec 31)	0.1					
6a - 12p		0.4		0.5	0.020	0
			0.6	0.5	0.030	0
12p – 6a		0.4		0.5	0.020	0
			0.6	0.5	0.030	0
Summer (Jun 1 – Oct 31)	0.9					
6a - 12p		0.4		0.5	0.180	2
			0.6	0.5	0.270	3
12p – 6a		0.4		0.5	0.180	2
			0.6	0.5	0.270	3
Total Days for Roving Shoreline Surveys						10
Total Angler Survey Days - 2001						71

Appendix 1b. Estimated angler use probabilities assigned to various strata to determine number of days to sample (angler surveys) in each stratum during 2002. All estimates were derived from data collected during 2001. The number of sample days was adjusted from 0 to 1 to ensure that all strata were sampled.

Sampling Period	Seasonal	Weekday	Weekend-Holiday	Time Period	Total Probability	Number of Sample Days	Adjusted Number of Days
Access Point Surveys							
Winter (Jan 1 – Jan 31; Nov 1 – Dec 31)	0.15						
6a – 10a		0.35		0.20	0.011	1	1
			0.65	0.10	0.010	1	1
10a - 2p		0.35		0.35	0.018	1	1
			0.65	0.40	0.039	2	2
2p - 6p		0.35		0.35	0.018	1	1
			0.65	0.40	0.039	2	2
6p - 10a		0.35		0.05	0.003	0	1
			0.65	0.05	0.005	0	1
10p – 6a		0.35		0.05	0.003	0	1
			0.65	0.05	0.005	0	1
Spring (Feb 1 – May 31)	0.35						
6a – 10a		0.40		0.15	0.021	1	1
			0.60	0.15	0.032	2	2
10a - 2p		0.40		0.55	0.077	4	4
			0.60	0.35	0.074	4	4
2p - 6p		0.40		0.20	0.028	2	2
			0.60	0.30	0.063	4	4
6p - 10a		0.40		0.05	0.007	0	1
			0.60	0.15	0.032	2	2
10p – 6a		0.40		0.05	0.007	0	1
			0.60	0.05	0.011	1	1
Summer (Jun 1- Oct 31)	0.50						
6a – 10a		0.40		0.20	0.040	2	2
			0.60	0.40	0.120	7	7
10a - 2p		0.40		0.45	0.090	5	5
			0.60	0.40	0.120	7	7
2p - 6p		0.40		0.15	0.030	2	2
			0.60	0.10	0.030	2	2
6p - 10a		0.40		0.10	0.020	1	1
			0.60	0.05	0.015	1	1
10p – 6a		0.40		0.10	0.020	1	1
			0.60	0.05	0.015	1	1
Total Days for Access Point Surveys						57	63

Appendix 1b (cont.).

Sampling Period	Seasonal	Weekday	Weekend-Holiday	Time Period	Total Probability	Number of Sample Days	Adjusted Number of Days
Roving Agua Fria Surveys							
Closure (Dec 15 – Mar 01)			Did not sample due to low water levels				
Closure (Mar 01 – Jun 01)	1.0						
6a – 10a		0.30		0.40	0.120	1	1
			0.70	0.40	0.280	2	2
10a – 2p		0.30		0.35	0.105	1	1
			0.70	0.35	0.245	2	2
2p – 6p		0.30		0.25	0.075	0	1
			0.70	0.25	0.175	1	1
Total Days for Roving Agua Fria Surveys						7	8
Shoreline Surveys							
Winter (Jan 1 – Jan 31; Nov 1 – Dec 31)	0.30						
6a – 10a		0.25		0.33	0.025	0	1
			0.75	0.33	0.074	1	1
10a - 2p		0.25		0.33	0.025	0	1
			0.75	0.33	0.074	1	1
2p - 6p		0.25		0.33	0.025	0	1
			0.75	0.33	0.074	1	1
Spring (Feb 1 – May 31)	0.40						
6a – 10a		0.25		0.40	0.040	0	1
			0.75	0.40	0.120	1	1
10a - 2p		0.25		0.30	0.030	0	1
			0.75	0.30	0.090	1	1
2p - 6p		0.25		0.30	0.030	0	1
			0.75	0.30	0.090	1	1
Summer (Jun 1- Oct 31)	0.30						
6a – 10a		0.25		0.50	0.038	0	1
			0.75	0.50	0.113	1	1
10a - 2p		0.25		0.30	0.023	0	1
			0.75	0.30	0.068	0	1
2p - 6p		0.25		0.20	0.015	0	1
			0.75	0.20	0.045	0	1
Total Days for Roving Shoreline Surveys						7	18
Total Angler Survey Days - 2002						71	89

Appendix 1c. Estimated angler use probabilities assigned to various strata to determine number of days to sample (angler surveys) in each stratum during 2003. All estimates were derived from data collected during 2002. The number of sample days was adjusted from 0 to 1 to ensure that all strata were sampled.

Sampling Period	Seasonal	Weekday	Weekend-Holiday	Time Period	Total Probability	Number of Sample Days	Adjusted Number of Days
Access Point Surveys							
Winter (Jan 1 – Jan 31; Nov 1 – Dec 31)	0.15						
6a – 10a		0.35		0.10	0.005	0	1
			0.65	0.10	0.010	1	1
10a - 2p		0.35		0.35	0.018	1	1
			0.65	0.40	0.039	2	2
2p - 6p		0.35		0.40	0.018	1	1
			0.65	0.40	0.039	2	2
6p - 10a		0.35		0.10	0.005	0	1
			0.65	0.05	0.005	0	1
10p – 6a		0.35		0.05	0.003	0	1
			0.65	0.05	0.005	0	1
Spring (Feb 1 – May 31)	0.35						
6a – 10a		0.40		0.15	0.021	1	1
			0.60	0.15	0.032	2	2
10a - 2p		0.40		0.55	0.077	4	4
			0.60	0.35	0.074	4	4
2p - 6p		0.40		0.20	0.028	2	2
			0.60	0.30	0.063	4	4
6p - 10a		0.40		0.05	0.007	0	1
			0.60	0.15	0.032	2	2
10p – 6a		0.40		0.05	0.007	1	1
			0.60	0.05	0.011	1	1
Summer (Jun 1- Oct 31)	0.50						
6a – 10a		0.40		0.20	0.040	2	2
			0.60	0.40	0.120	7	7
10a - 2p		0.40		0.45	0.090	5	5
			0.60	0.40	0.120	7	7
2p - 6p		0.40		0.15	0.030	2	2
			0.60	0.10	0.030	2	2
6p - 10a		0.40		0.10	0.020	1	1
			0.60	0.05	0.015	1	1
10p – 6a		0.40		0.10	0.020	1	1
			0.60	0.05	0.015	1	1
Total Days for Access Point Surveys						57	63

Appendix 1c (cont.).

Sampling Period	Seasonal	Weekday	Weekend-Holiday	Time Period	Total Probability	Number of Sample Days	Adjusted Number of Days
Roving Agua Fria Surveys							
Closure (Dec 15 – Mar 01)			Did not sample due to low water levels				
Closure (Mar 01 – Jun 01)	1.0						
6a – 10a		0.30		0.40	0.120	1	1
			0.70	0.40	0.280	2	2
10a – 2p		0.30		0.35	0.105	1	1
			0.70	0.35	0.245	2	2
2p – 6p		0.30		0.25	0.060	0	1
			0.70	0.25	0.140	1	1
Total Days for Roving Agua Fria Surveys						7	8
Shoreline Surveys							
Winter (Jan 1 – Jan 31; Nov 1 – Dec 31)	0.30						
6a – 10a		0.25		0.33	0.025	0	1
			0.75	0.33	0.074	1	1
10a - 2p		0.25		0.33	0.025	0	1
			0.75	0.33	0.074	1	1
2p - 6p		0.25		0.33	0.025	0	1
			0.75	0.33	0.074	1	1
Spring (Feb 1 – May 31)	0.40						
6a – 10a		0.25		0.40	0.040	0	1
			0.75	0.40	0.120	1	1
10a - 2p		0.25		0.30	0.030	0	1
			0.75	0.30	0.090	1	1
2p - 6p		0.25		0.30	0.030	0	1
			0.75	0.30	0.090	1	1
Summer (Jun 1- Oct 31)	0.30						
6a – 10a		0.25		0.60	0.045	0	1
			0.75	0.60	0.135	1	1
10a - 2p		0.25		0.30	0.023	0	1
			0.75	0.30	0.068	0	1
2p - 6p		0.25		0.10	0.008	0	1
			0.75	0.10	0.023	0	1
Total Days for Roving Shoreline Surveys						7	18
Total Angler Survey Days - 2003						71	89

Appendix 1d. Estimated angler use probabilities assigned to various strata to determine number of days to sample (angler surveys) in each stratum during 2004. All estimates were derived from data collected during 2003. The number of sample days was adjusted from 0 to 1 to ensure that all strata were sampled.

Sampling Period	Seasonal	Weekday	Weekend-Holiday	Time Period	Total Probability	Number of Sample Days	Adjusted Number of Days
Access Point Surveys							
Winter (Jan 1 – Jan 31; Nov 1 – Dec 31)	0.20						
6a – 10a		0.30		0.05	0.003	0	1
			0.70	0.05	0.007	0	1
10a - 2p		0.30		0.40	0.024	1	1
			0.70	0.20	0.028	2	2
2p - 6p		0.30		0.40	0.024	1	1
			0.70	0.60	0.084	5	5
6p - 10a		0.30		0.10	0.006	0	1
			0.70	0.10	0.014	1	1
10p – 6a		0.30		0.05	0.003	0	1
			0.70	0.05	0.007	0	1
Spring (Feb 1 – May 31)	0.45						
6a – 10a		0.30		0.05	0.007	1	1
			0.70	0.10	0.032	2	2
10a - 2p		0.30		0.55	0.074	4	4
			0.70	0.50	0.158	9	9
2p - 6p		0.30		0.25	0.034	2	2
			0.70	0.25	0.079	4	4
6p - 10a		0.30		0.10	0.014	1	1
			0.70	0.10	0.032	2	2
10p – 6a		0.30		0.05	0.007	1	1
			0.70	0.05	0.016	1	1
Summer (Jun 1- Oct 31)	0.35	0.30					
6a – 10a			0.70	0.10	0.011	1	1
		0.30		0.25	0.061	3	3
10a - 2p			0.70	0.55	0.058	3	3
		0.30		0.50	0.123	7	7
2p - 6p			0.70	0.15	0.016	1	1
		0.30		0.15	0.037	2	2
6p - 10a			0.70	0.15	0.016	1	1
		0.30		0.05	0.012	1	1
10p – 6a			0.70	0.05	0.005	0	1
		0.30		0.05	0.012	1	1
			0.70				
Total Days for Access Point Surveys						57	63

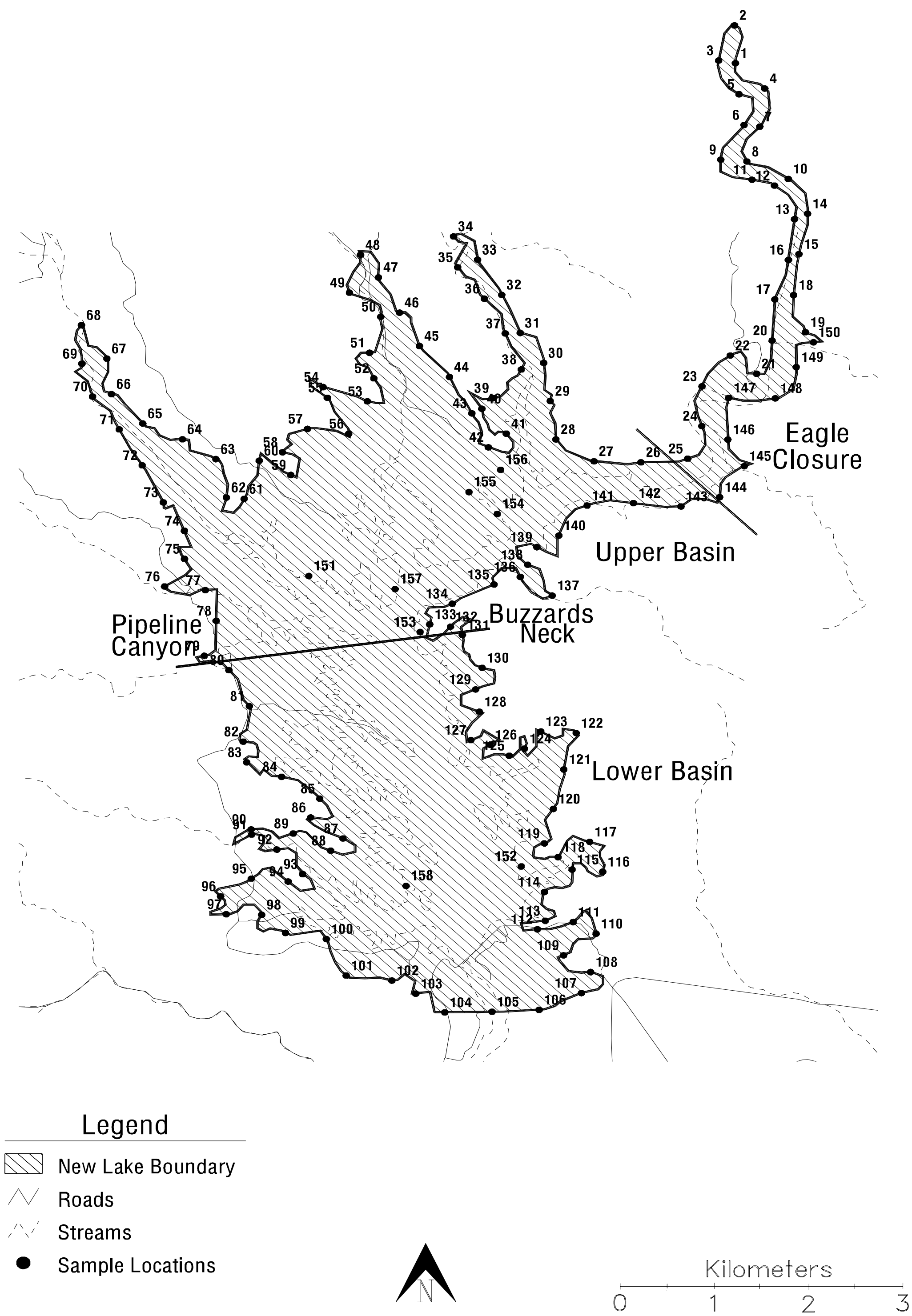
Appendix 1d (cont.).

Sampling Period	Seasonal	Weekday	Weekend-Holiday	Time Period	Total Probability	Number of Sample Days	Adjusted Number of Days
Roving Agua Fria Surveys							
Closure (Dec 15 – Mar 01)			Did not sample due to low water levels				
Closure (Mar 01 – Jun 01)	1.0						
6a – 10a		0.30		0.35	0.105	1	1
			0.70	0.35	0.245	2	3
10a – 2p		0.30		0.45	0.135	1	2
			0.70	0.45	0.315	2	4
2p – 6p		0.30		0.20	0.060	0	1
			0.70	0.20	0.140	1	2
Total Days for Roving Agua Fria Surveys						7	13
Shoreline Surveys							
Winter (Jan 1 – Jan 31; Nov 1 – Dec 31)	0.30						
6a – 10a		0.25		0.33	0.025	0	1
			0.75	0.33	0.074	1	1
10a - 2p		0.25		0.33	0.025	0	1
			0.75	0.33	0.074	1	1
2p - 6p		0.25		0.33	0.025	0	1
			0.75	0.33	0.074	1	1
Spring (Feb 1 – May 31)	0.40						
6a – 10a		0.25		0.40	0.040	0	1
			0.75	0.40	0.120	1	1
10a - 2p		0.25		0.30	0.030	0	1
			0.75	0.30	0.090	1	1
2p - 6p		0.25		0.30	0.030	0	1
			0.75	0.30	0.090	1	1
Summer (Jun 1- Oct 31)	0.30						
6a – 10a		0.25		0.60	0.045	0	1
			0.75	0.60	0.135	1	1
10a - 2p		0.25		0.30	0.023	0	1
			0.75	0.30	0.068	0	1
2p - 6p		0.25		0.10	0.008	0	1
			0.75	0.10	0.023	0	1
Total Days for Roving Shoreline Surveys						7	18
Total Angler Survey Days - 2004						71	94

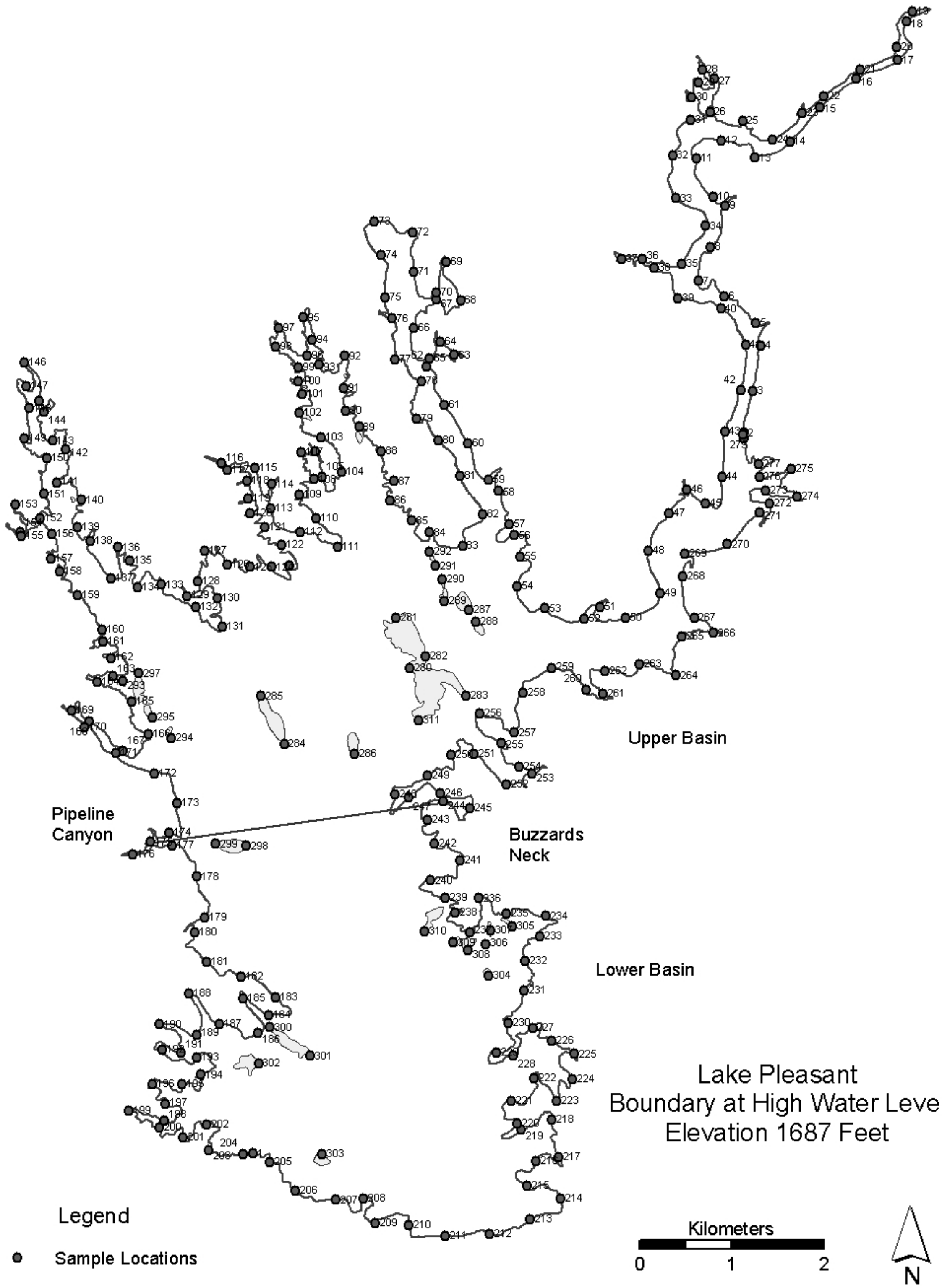
Appendix 2. Angler use probability used to determine number of sample days needed at each boat ramp (based on total adjusted sample days) for access point angler surveys. Probabilities are based on the expert opinion of biologists, lake managers, and park supervisors.

Access Point	2001		2002		2003		2004	
	Probability	Number of Sampling Days	Probability	Number of Sampling Days	Probability	Number of Sampling Days	Probability	Number of Sampling Days
Pleasant Harbor	0.10	6	0.15	9	0.15	9	0.20	16
South Park	0.30	17	0.35	22	0.35	22	0.35	20
Castle Bay	0.60	34	0.50	32	0.50	32	0.45	27

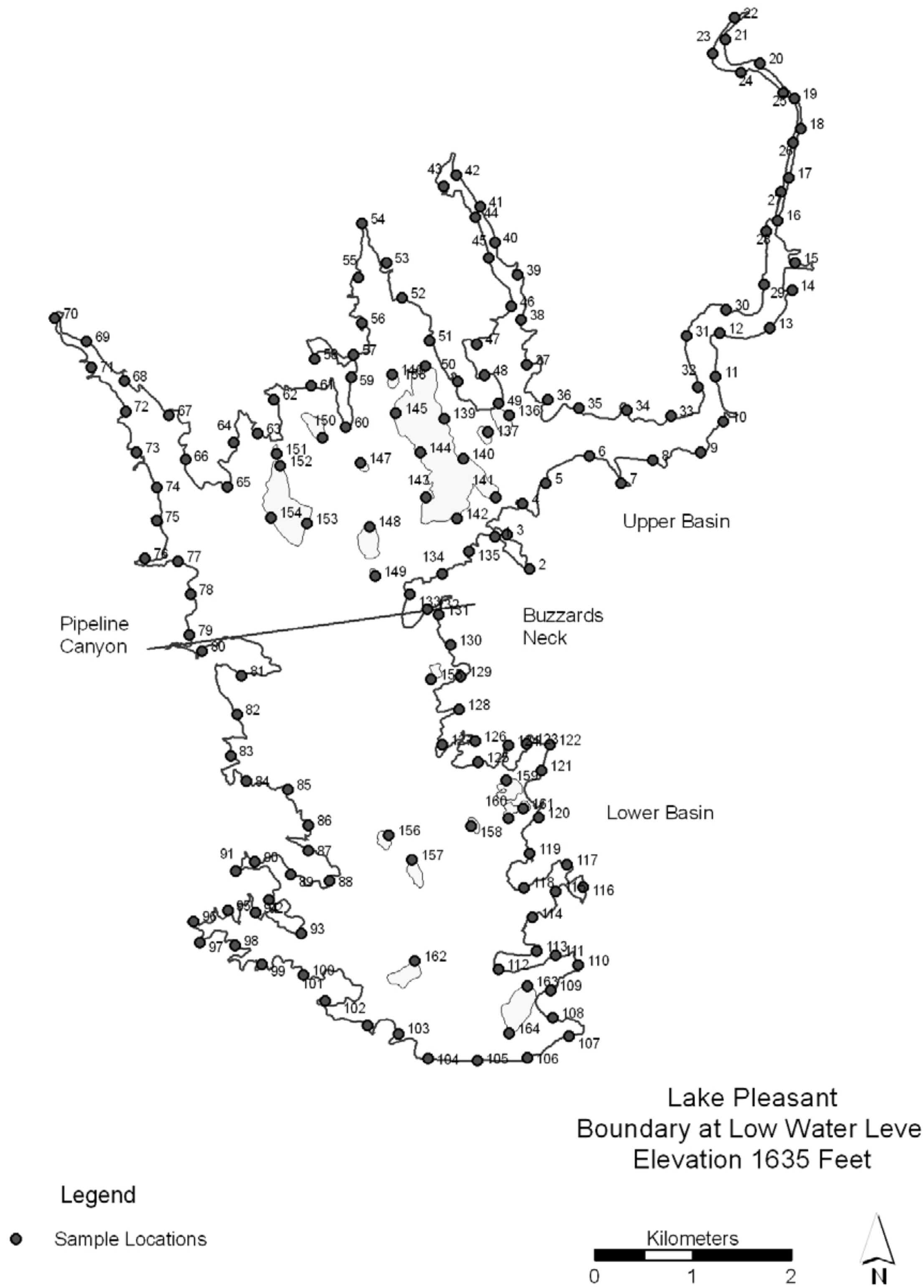
Appendix 3a. Map of Lake Pleasant at conservation pool. Numbered points represent potential sampling locations for gill netting and electrofishing from November 2000 to May 2001.



Appendix 3b. Map of Lake Pleasant at high water levels. Numbered points represent potential sampling locations for gill netting and electrofishing during Spring 2002-2004.



Appendix 3c. Map of Lake Pleasant at low water levels. Numbered points represent potential sampling locations for gill netting and electrofishing during Fall 2001-2003.



Appendix 4. Total estimated angling pressure (hours) on Lake Pleasant, 2001-2004. For access and shoreline roving surveys, spring is February-May, summer is June–October, and winter is November–January. For the Agua Fria River, all surveys were conducted from March 1–June 15.

			2001		2002		2003		2004	
Method	Time of Year	Day of Week	Angler Hours	SE	Angler Hours	SE	Angler Hours	SE	Angler Hours	SE
Access	Spring	weekday	173,319	47,046	57,708	32,359	117,311	45,617	118,202	44,865
	Spring	weekend/holiday	126,774	46,419	84,195	23,732	105,398	31,062	114,644	49,119
	Summer	weekday	115,350	25,480	94,672	28,093	64,384	20,235	92,801	45,974
	Summer	weekend/holiday	119,275	28,979	99,774	39,067	84,191	31,661	33,606	10,768
	Winter	weekday	77,161	39,004	52,460	34,585	7,017	4,071	15,120	15,120
	Winter	weekend/holiday	93,562	55,604	34,283	10,059	39,140	13,652	19,564	15,865
Subtotal			705,440	102,324	423,091	72,271	417,441	68,269	393,938	84,472
Roving: Agua Fria	Closure	weekday	6,468	--	15,840	5,280	13,434	4,080	7,725	4,896
		weekend/holiday	10,020	1,752	6,658	2,484	5,292	2,168	9,466	2,959
Subtotal			16,488	1,752	22,498	5,835	18,726	4,621	17,191	5,720
Roving: Shoreline	Spring	weekday	--	--	--	--	--	--	12,752	7,157
	Spring	weekend/holiday	--	--	9,120	--	25,145	9,111	38,505	11,173
	Summer	weekday	15,562	5,657	5,182	3,062	16,853	7,945	8,084	5,771
	Summer	weekend/holiday	22,298	6,498	10,271	2,996	12,778	6,506	19,013	15,027
	Winter	weekday	--	--	2,957	1,479	2,834	1,514	8,040	6,068
	Winter	weekend/holiday	--	--	4,196	1,303	8,830	2,070	3,134	1,573
Subtotal			37,860	8,616	31,727	4,716	66,440	13,966	89,529	21,782
Total Effort			759,788	102,701	477,317	72,659	502,607	69,836	500,658	87,422

Appendix 5a. Estimates of angler catch for individual species and survey strata in Lake Pleasant, 2001. Standard errors are in parentheses. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Striped Bass	Catfish
Access	Spring	Weekday	61,081 (23,152)	82,143 (31,293)	0 (0)	637 (244)
		Weekend	28,561 (11,184)	18,481 (7,304)	468 (184)	433 (169)
		Spring Total	89,642 (25,711)	100,624 (32,134)	468 (184)	1,070 (297)
	Summer	Weekday	30,794 (8,335)	3,861 (1,062)	274 (76)	2,308 (622)
		Weekend	19,322 (4,407)	10,007 (2,341)	730 (170)	1,195 (272)
		Summer Total	50,116 (9,428)	13,868 (2,571)	1,004 (186)	3,503 (678)
	Winter	Weekday	22,202 (9,307)	4,786 (1,966)	687 (291)	0 (0)
		Weekend	12,084 (5,475)	8,049 (3,764)	294 (135)	500 (232)
		Winter Total	34,286 (10,798)	12,836 (4,246)	981 (321)	500 (232)
	Access Total		174,044 (29,437)	127,327 (32,515)	2,454 (414)	5,072 (776)
Shoreline	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Spring Total	-- (--)	-- (--)	-- (--)	-- (--)
	Summer	Weekday	2,811 (1,960)	0 (0)	0 (0)	284 (199)
		Weekend	276 (137)	0 (0)	0 (0)	1,618 (803)
		Summer Total	3,087 (1,965)	0 (0)	0 (0)	1,902 (827)
	Winter	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Winter Total	-- (--)	-- (--)	-- (--)	-- (--)
	Shoreline Total		3,087 (1,965)	0 (0)	0 (0)	1,902 (827)
Agua Fria	March 1 – June 15	Weekday	4,777 (-)	0 (0)	0 (0)	0 (0)
	March 1 – June 15	Weekend	1,534 (1,081)	1,170 (825)	15 (11)	19 (14)
	Agua Fria Total		6,311 (1,081)	1,170 (825)	15 (11)	19 (14)
Lake Total			183,442 (29,523)	128,497 (32,526)	2,469 (414)	6,994 (1,134)

Appendix 5a (cont).

Survey Type	Season	Day of Week	Common Carp	Crappie	Sunfish	Total
Access	Spring	Weekday	405 (156)	2,027 (776)	623 (237)	146,917 (55,777)
		Weekend	0 (0)	663 (262)	732 (284)	49,338 (19,373)
		Spring Total	405 (156)	2,690 (820)	1,355 (370)	196,255 (59,045)
	Summer	Weekday	0 (0)	4,518 (1,266)	1,984 (550)	43,738 (11,875)
		Weekend	0 (0)	588 (136)	3,585 (820)	35,427 (8,134)
		Summer Total	0 (0)	5,106 (1,273)	5,569 (988)	79,166 (14,394)
	Winter	Weekday	0 (0)	0 (0)	1,202 (508)	28,878 (12,059)
		Weekend	0 (0)	792 (372)	344 (163)	22,063 (10,130)
		Winter Total	0 (0)	792 (372)	1,546 (534)	50,941 (15,750)
	Access Total		405 (156)	8,589 (1,559)	8,470 (1,182)	326,361 (62,782)
Shoreline	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Spring Total	-- (--)	-- (--)	-- (--)	-- (--)
	Summer	Weekday	0 (0)	0 (0)	2,737 (1,912)	5,833 (4,072)
		Weekend	152 (76)	0 (0)	3,598 (1,792)	5,644 (2,808)
		Summer Total	152 (76)	0 (0)	6,335 (2,621)	11,476 (4,946)
	Winter	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Winter Total	-- (--)	-- (--)	-- (--)	-- (--)
	Shoreline Total		152 (76)	0 (0)	6,335 (2,621)	11,476 (4,946)
Agua Fria	March 1 – June 15	Weekday	0 (0)	0 (0)	0 (0)	4,777 (-)
	March 1 – June 15	Weekend	0 (0)	456 (314)	35 (24)	3,219 (2,269)
	Agua Fria Total		0 (0)	456 (314)	35 (24)	7,996 (2,269)
Lake Total			558 (173)	9,034 (1,591)	14,840 (2,875)	345,834 (63,017)

Appendix 5b. Estimates of angler harvest for individual species and survey strata in Lake Pleasant, 2001. Standard errors are in parentheses. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Striped Bass	Catfish
Access	Spring	Weekday	3,779 (1,401)	58,977 (22,461)	0 (0)	434 (166)
		Weekend	3,762 (1,496)	13,384 (5,321)	369 (145)	174 (69)
		Spring Total	7,541 (2,050)	72,361 (23,083)	369 (145)	608 (180)
	Summer	Weekday	3,381 (920)	2,424 (679)	274 (76)	1,309 (361)
		Weekend	2,560 (583)	5,258 (1,233)	357 (83)	355 (81)
		Summer Total	5,941 (1,089)	7,682 (1,407)	631 (145)	1,664 (370)
	Winter	Weekday	1,374 (581)	975 (396)	515 (219)	0 (0)
		Weekend	2,186 (1,003)	3,368 (1,569)	265 (124)	329 (156)
		Winter Total	3,560 (1,159)	4,343 (1,618)	780 (252)	329 (156)
	Access Total		17,042 (2,594)	84,384 (23,182)	1,780 (311)	2,601 (440)
Shoreline	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Spring Total	-- (--)	-- (--)	-- (--)	-- (--)
	Summer	Weekday	1,004 (698)	0 (0)	0 (0)	0 (0)
		Weekend	72 (36)	0 (0)	0 (0)	798 (396)
		Summer Total	1,076 (699)	0 (0)	0 (0)	798 (396)
	Winter	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Winter Total	-- (--)	-- (--)	-- (--)	-- (--)
	Shoreline Total		1,076 (699)	0 (0)	0 (0)	798 (396)
Agua Fria	March 1 – June 15	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
	March 1 – June 15	Weekend	736 (519)	593 (418)	15 (11)	19 (14)
	Agua Fria Total		736 (519)	593 (418)	15 (11)	19 (14)
Lake Total			18,853 (2,737)	84,978 (23,186)	1,796 (311)	3,418 (592)

Appendix 5b (cont).

Survey Type	Season	Day of Week	Common Carp	Crappie	Sunfish	Total
Access	Spring	Weekday	0 (0)	2,027 (776)	567 (216)	65,783 (24,967)
		Weekend	0 (0)	87 (35)	261 (104)	18,036 (7,162)
		Spring Total	0 (0)	2,114 (777)	827 (240)	83,819 (25,974)
	Summer	Weekday	0 (0)	3,581 (1,005)	496 (139)	11,466 (3,152)
		Weekend	0 (0)	289 (68)	1,304 (299)	10,123 (2,339)
		Summer Total	0 (0)	3,871 (1,007)	1,780 (329)	21,589 (3,925)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	2,864 (1,188)
		Weekend	0 (0)	105 (50)	105 (50)	6,357 (2,947)
		Winter Total	0 (0)	105 (50)	105 (50)	9,222 (3,177)
	Access Total		0 (0)	6,089 (1,273)	2,732 (410)	114,629 (26,460)
Shoreline	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Spring Total	-- (--)	-- (--)	-- (--)	-- (--)
	Summer	Weekday	0 (0)	0 (0)	0 (0)	1,004 (698)
		Weekend	152 (76)	0 (0)	1,332 (663)	2,355 (1,171)
		Summer Total	152 (76)	0 (0)	1,332 (663)	3,359 (1,364)
	Winter	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Winter Total	-- (--)	-- (--)	-- (--)	-- (--)
	Shoreline Total		152 (76)	0 (0)	1,332 (663)	3,359 (1,364)
Agua Fria	March 1 – June 15	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
	March 1 – June 15	Weekend	0 (0)	315 (223)	1,333 (24)	1,714 (1,209)
	Agua Fria Total		0 (0)	315 (223)	1,333 (24)	1,714 (1,209)
Lake Total			152 (76)	6,405 (1,292)	4,099 (780)	119,702 (26,523)

Appendix 5c. Estimates of angler catch for individual species and survey strata in Lake Pleasant, 2002. Standard errors are in parentheses. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Striped Bass	Catfish
Access	Spring	Weekday	8,560 (2,825)	6,705 (2,310)	465 (165)	0 (0)
		Weekend	13,301 (4,637)	5,598 (1,951)	197 (70)	173 (60)
		Spring Total	21,961 (5,430)	12,303 (3,023)	662 (178)	173 (60)
	Summer	Weekday	19,149 (5,787)	9,715 (2,847)	213 (76)	1,216 (370)
		Weekend	12,420 (2,785)	15,555 (3,527)	134 (30)	4,139 (947)
		Summer Total	31,569 (6,422)	25,270 (4,532)	347 (82)	5,355 (1,016)
	Winter	Weekday	4,238 (2,403)	296 (163)	1,215 (693)	2,430 (1,386)
		Weekend	3,150 (1,086)	2,133 (741)	198 (71)	261 (94)
		Winter Total	7,388 (2,637)	2,430 (759)	1,413 (697)	2,690 (1,389)
	Access Total		60,917 (8,814)	40,003 (5,501)	2,421 (724)	8,219 (1,722)
Shoreline	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	0 (0)	912 (-)	0 (0)	1,398 (-)
		Spring Total	0 (0)	912 (-)	0 (0)	1,398 (-)
	Summer	Weekday	837 (587)	0 (0)	0 (0)	79 (53)
		Weekend	178 (88)	0 (0)	0 (0)	186 (92)
		Summer Total	1,015 (593)	0 (0)	0 (0)	265 (106)
	Winter	Weekday	0 (0)	0 (0)	106 (104)	148 (142)
		Weekend	191 (133)	0 (0)	0 (0)	56 (39)
		Winter Total	191 (133)	0 (0)	106 (104)	204 (147)
	Shoreline Total		1,206 (608)	912 (-)	106 (104)	1,866 (182)
Agua Fria	March 1 – June 15	Weekday	3,153 (3,142)	3,851 (3,829)	384 (383)	0 (0)
	March 1 – June 15	Weekend	735 (366)	2,226 (1,110)	181 (90)	51 (25)
	Agua Fria Total		3,888 (3,163)	6,077 (3,986)	565 (393)	51 (25)
Lake Total			66,012 (9,384)	46,991 (6,793)	3,092 (830)	10,136 (1,732)

Appendix 5c (cont).

Survey Type	Season	Day of Week	Common Carp	Crappie	Sunfish	Total
Access	Spring	Weekday	0 (0)	174 (62)	433 (156)	16,437 (5,466)
		Weekend	0 (0)	668 (234)	332 (114)	20,267 (7,062)
		Spring Total	0 (0)	842 (242)	765 (194)	36,704 (8,930)
	Summer	Weekday	0 (0)	656 (204)	4,682 (1,383)	35,631 (10,591)
		Weekend	0 (0)	6,016 (1,405)	1,752 (390)	40,015 (9,072)
		Summer Total	0 (0)	6,671 (1,419)	6,434 (1,437)	75,646 (13,946)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	8,180 (4,644)
		Weekend	0 (0)	66 (24)	66 (24)	5,873 (2,034)
		Winter Total	0 (0)	66 (24)	66 (24)	14,053 (5,070)
	Access Total		0 (0)	7,579 (1,440)	7,265 (1,450)	126,404 (17,319)
Shoreline	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	0 (0)	0 (0)	0 (0)	2,310 (-)
		Spring Total	0 (0)	0 (0)	0 (0)	2,310 (-)
	Summer	Weekday	0 (0)	0 (0)	1,256 (846)	2,172 (1,485)
		Weekend	0 (0)	0 (0)	141 (70)	504 (250)
		Summer Total	0 (0)	0 (0)	1,397 (849)	2,677 (1,506)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	254 (246)
		Weekend	36 (25)	0 (0)	0 (0)	282 (197)
		Winter Total	36 (25)	0 (0)	0 (0)	536 (277)
	Shoreline Total		36 (25)	0 (0)	1,397 (849)	5,523 (1,538)
Agua Fria	March 1 – June 15	Weekday	0 (0)	2,672 (2,659)	0 (0)	10,060 (10,012)
	March 1 – June 15	Weekend	0 (0)	108 (54)	0 (0)	3,301 (1,646)
	Agua Fria Total		0 (0)	2,780 (2,659)	0 (0)	13,361 (10,146)
Lake Total			36 (25)	10,360 (3,024)	8,662 (1,681)	145,288 (20,131)

Appendix 5d. Estimates of angler harvest for individual species and survey strata in Lake Pleasant, 2002. Standard errors are in parentheses. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Striped Bass	Catfish
Access	Spring	Weekday	3,269 (1,183)	6,109 (2,109)	32 (13)	0 (0)
		Weekend	1,979 (678)	3,307 (1,148)	196 (70)	43 (16)
		Spring Total	5,248 (1,364)	9,416 (2,401)	228 (71)	43 (16)
	Summer	Weekday	1,884 (556)	5,244 (1,581)	0 (0)	765 (236)
		Weekend	1,002 (224)	8,673 (2,005)	10 (3)	1,022 (229)
		Summer Total	2,886 (599)	13,917 (2,553)	10 (3)	1,787 (329)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
		Weekend	330 (118)	1,283 (455)	132 (48)	132 (48)
		Winter Total	330 (118)	1,283 (455)	132 (48)	132 (48)
	Access Total		8,464 (1,495)	23,636 (3,534)	370 (85)	1,962 (333)
Shoreline	Spring	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
		Weekend	0 (0)	912 (-)	0 (0)	942 (-)
		Spring Total	0 (0)	912 (-)	0 (0)	942 (-)
	Summer	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
		Weekend	22 (11)	0 (0)	0 (0)	41 (20)
		Summer Total	22 (11)	0 (0)	0 (0)	41 (20)
	Winter	Weekday	0 (0)	0 (0)	106 (104)	148 (142)
		Weekend	157 (109)	0 (0)	0 (0)	28 (20)
		Winter Total	157 (109)	0 (0)	106 (104)	176 (143)
	Shoreline Total		178 (109)	912 (-)	106 (104)	1,159 (145)
Agua Fria	March 1 – June 15	Weekday	1,681 (1,675)	3,587 (3,567)	384 (383)	0 (0)
	March 1 – June 15	Weekend	267 (133)	2,099 (1,047)	167 (83)	32 (16)
	Agua Fria Total		1,948 (1,680)	5,686 (3,718)	551 (392)	32 (16)
Lake Total			10,591 (2,252)	31,214 (5,129)	1,026 (414)	3,152 (363)

Appendix 5d (cont).

Survey Type	Season	Day of Week	Common Carp	Crappie	Sunfish	Total
Access	Spring	Weekday	0 (0)	0 (0)	0 (0)	9,410 (3,262)
		Weekend	0 (0)	516 (182)	135 (46)	6,176 (2,130)
		Spring Total	0 (0)	516 (182)	135 (46)	15,585 (3,895)
	Summer	Weekday	0 (0)	0 (0)	0 (0)	7,894 (2,358)
		Weekend	0 (0)	3,239 (756)	250 (55)	14,197 (3,268)
		Summer Total	0 (0)	3,239 (756)	250 (55)	22,091 (4,029)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
		Weekend	0 (0)	66 (24)	66 (24)	2,008 (713)
		Winter Total	0 (0)	66 (24)	66 (24)	2,008 (713)
	Access Total		0 (0)	3,821 (778)	452 (76)	39,684 (5,650)
Shoreline	Spring	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
		Weekend	0 (0)	0 (0)	0 (0)	1,854 (-)
		Spring Total	0 (0)	0 (0)	0 (0)	1,854 (-)
	Summer	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
		Weekend	0 (0)	0 (0)	14 (7)	77 (38)
		Summer Total	0 (0)	0 (0)	14 (7)	77 (38)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	254 (246)
		Weekend	0 (0)	0 (0)	0 (0)	184 (128)
		Winter Total	0 (0)	0 (0)	0 (0)	438 (278)
	Shoreline Total		0 (0)	0 (0)	14 (7)	2,370 (280)
Agua Fria	March 1 – June 15	Weekday	0 (0)	2,672 (2,659)	0 (0)	8,325 (8,283)
	March 1 – June 15	Weekend	0 (0)	108 (54)	0 (0)	2,672 (1,332)
	Agua Fria Total		0 (0)	2,780 (2,659)	0 (0)	10,997 (8,390)
Lake Total			0 (0)	6,602 (2,771)	466 (76)	53,051 (10,119)

Appendix 5e. Estimates of angler catch for individual species and survey strata in Lake Pleasant, 2003. Standard errors are in parentheses. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Striped Bass	Catfish
Access	Spring	Weekday	18,174 (6,118)	14,700 (4,911)	803 (266)	747 (255)
		Weekend	19,208 (6,023)	21,535 (6,876)	468 (145)	252 (79)
		Spring Total	37,381 (8,585)	36,236 (8,449)	1,271 (303)	998 (267)
	Summer	Weekday	13,947 (3,729)	278 (75)	0 (0)	639 (175)
		Weekend	8,427 (2,022)	5,821 (1,378)	695 (170)	2,065 (484)
		Summer Total	22,374 (4,242)	6,099 (1,379)	695 (170)	2,705 (515)
	Winter	Weekday	931 (504)	147 (78)	0 (0)	0 (0)
		Weekend	6,057 (2,003)	6,962 (2,377)	29 (10)	885 (306)
		Winter Total	6,987 (2,066)	7,109 (2,378)	29 (10)	885 (306)
	Access Total		66,743 (9,796)	49,444 (8,885)	1,995 (348)	4,588 (655)
Shoreline	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	176 (176)	599 (598)	0 (0)	105 (105)
		Spring Total	176 (176)	599 (598)	0 (0)	105 (105)
	Summer	Weekday	1,599 (913)	178 (102)	0 (0)	927 (529)
		Weekend	613 (433)	0 (0)	273 (192)	1,306 (921)
		Summer Total	2,212 (1,010)	178 (102)	273 (192)	2,233 (1,062)
	Winter	Weekday	863 (603)	123 (86)	0 (0)	0 (0)
		Weekend	0 (0)	0 (0)	0 (0)	0 (0)
		Winter Total	863 (603)	123 (86)	0 (0)	0 (0)
	Shoreline Total		3,251 (1,189)	900 (613)	273 (192)	2,338 (1,068)
Agua Fria	March 1 – June 15	Weekday	2,067 (414)	16,901 (3,390)	0 (0)	573 (115)
	March 1 – June 15	Weekend	79 (39)	847 (422)	0 (0)	73 (37)
	Agua Fria Total		2,146 (416)	17,747 (3,416)	0 (0)	647 (121)
Lake Total			72,141 (9,877)	68,092 (9,539)	2,268 (397)	7,572 (1,258)

Appendix 5e (cont).

Survey Type	Season	Day of Week	Common Carp	Crappie	Sunfish	Total
Access	Spring	Weekday	0 (0)	0 (0)	3,962 (1,350)	38,386 (12,877)
		Weekend	126 (40)	41 (13)	422 (136)	42,052 (13,302)
		Spring Total	126 (40)	41 (13)	4,384 (1,357)	80,439 (18,513)
	Summer	Weekday	0 (0)	209 (57)	14,992 (4,088)	30,066 (8,087)
		Weekend	45 (14)	1,051 (249)	1,282 (293)	19,387 (4,577)
		Summer Total	45 (14)	1,260 (256)	16,274 (4,099)	49,453 (9,293)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	1,078 (580)
		Weekend	0 (0)	236 (79)	177 (59)	14,345 (4,829)
		Winter Total	0 (0)	236 (79)	177 (59)	15,423 (4,864)
	Access Total		171 (42)	1,538 (268)	20,835 (4,318)	145,314 (21,278)
Shoreline	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	195 (195)	0 (0)	1,188 (1,185)	2,263 (2,258)
		Spring Total	195 (195)	0 (0)	1,188 (1,185)	2,263 (2,258)
	Summer	Weekday	0 (0)	0 (0)	1,966 (1,121)	4,670 (2,664)
		Weekend	0 (0)	0 (0)	513 (361)	2,704 (1,908)
		Summer Total	0 (0)	0 (0)	2,479 (1,177)	7,374 (3,277)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	986 (688)
		Weekend	0 (0)	0 (0)	0 (0)	0 (0)
		Winter Total	0 (0)	0 (0)	0 (0)	986 (688)
	Shoreline Total		195 (195)	0 (0)	3,666 (1,670)	10,623 (4,039)
Agua Fria	March 1 – June 15	Weekday	19 (4)	42 (8)	298 (60)	19,900 (3,991)
	March 1 – June 15	Weekend	32 (16)	36 (18)	119 (59)	1,186 (591)
	Agua Fria Total		51 (16)	78 (20)	417 (84)	21,086 (4,035)
Lake Total			418 (200)	1,615 (269)	24,918 (4,630)	177,024 (22,031)

Appendix 5f. Estimates of angler harvest for individual species and survey strata in Lake Pleasant, 2003. Standard errors are in parentheses. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Striped Bass	Catfish
Access	Spring	Weekday	5,111 (1,747)	7,293 (2,444)	431 (146)	747 (255)
		Weekend	3,871 (1,222)	13,708 (4,420)	41 (13)	196 (54)
		Spring Total	8,982 (2,132)	21,001 (5,051)	471 (147)	915 (261)
	Summer	Weekday	2,066 (557)	0 (0)	0 (0)	501 (138)
		Weekend	381 (90)	1,468 (350)	93 (22)	1,160 (271)
		Summer Total	2,447 (564)	1,468 (350)	93 (22)	1,662 (304)
	Winter	Weekday	261 (143)	0 (0)	0 (0)	0 (0)
		Weekend	663 (222)	2,595 (901)	14 (5)	767 (266)
		Winter Total	924 (264)	2,595 (901)	14 (5)	767 (266)
	Access Total		12,353 (2,221)	25,065 (5,142)	579 (149)	3,344 (481)
Shoreline	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	176 (176)	541 (541)	0 (0)	105 (105)
		Spring Total	176 (176)	541 (541)	0 (0)	105 (105)
	Summer	Weekday	1,421 (811)	0 (0)	0 (0)	665 (380)
		Weekend	0 (0)	0 (0)	0 (0)	79 (55)
		Summer Total	1,421 (811)	0 (0)	0 (0)	744 (384)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
		Weekend	0 (0)	0 (0)	0 (0)	0 (0)
		Winter Total	0 (0)	0 (0)	0 (0)	0 (0)
	Shoreline Total		1,597 (829)	541 (541)	0 (0)	849 (398)
Agua Fria	March 1 – June 15	Weekday	558 (112)	5,952 (1,194)	0 (0)	373 (75)
	March 1 – June 15	Weekend	58 (29)	516 (257)	0 (0)	73 (37)
	Agua Fria Total		616 (115)	6,469 (1,221)	0 (0)	446 (83)
Lake Total			14,566 (2,373)	32,075 (5,313)	579 (149)	4,639 (630)

Appendix 5f (cont).

Survey Type	Season	Day of Week	Common Carp	Crappie	Sunfish	Total
Access	Spring	Weekday	0 (0)	0 (0)	1,263 (435)	14,844 (5,018)
		Weekend	0 (0)	41 (13)	0 (0)	17,831 (5,716)
		Spring Total	0 (0)	41 (13)	1,263 (435)	32,675 (7,607)
	Summer	Weekday	0 (0)	138 (38)	2,881 (788)	5,587 (1,514)
		Weekend	0 (0)	727 (173)	691 (163)	4,520 (1,053)
		Summer Total	0 (0)	865 (178)	3,572 (805)	10,107 (1,844)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	261 (143)
		Weekend	0 (0)	118 (40)	59 (20)	4,217 (1,450)
		Winter Total	0 (0)	118 (40)	59 (20)	4,478 (1,457)
	Access Total		0 (0)	1,025 (182)	4,894 (915)	47,260 (7,961)
Shoreline	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	0 (0)	0 (0)	1,188 (1,185)	2,010 (2,006)
		Spring Total	0 (0)	0 (0)	1,188 (1,185)	2,010 (2,006)
	Summer	Weekday	0 (0)	0 (0)	1,296 (739)	3,382 (1,929)
		Weekend	0 (0)	0 (0)	0 (0)	79 (55)
		Summer Total	0 (0)	0 (0)	1,296 (739)	3,461 (1,930)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
		Weekend	0 (0)	0 (0)	0 (0)	0 (0)
		Winter Total	0 (0)	0 (0)	0 (0)	0 (0)
	Shoreline Total		0 (0)	0 (0)	2,484 (1,397)	5,471 (2,784)
Agua Fria	March 1 – June 15	Weekday	0 (0)	0 (0)	298 (60)	7,181 (1,440)
	March 1 – June 15	Weekend	32 (16)	36 (18)	0 (0)	716 (356)
	Agua Fria Total		32 (16)	36 (18)	298 (60)	7,897 (1,483)
Lake Total			32 (16)	1,061 (183)	7,676 (1,671)	60,627 (8,564)

Appendix 5g. Estimates of angler catch for individual species and survey strata in Lake Pleasant, 2004. Standard errors are in parentheses. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Striped Bass	Catfish
Access	Spring	Weekday	17,259 (5,748)	32,367 (10,971)	407 (137)	434 (148)
		Weekend	12,387 (3,027)	7,182 (1,777)	2,016 (512)	333 (82)
		Spring Total	29,645 (6,497)	39,549 (11,114)	2,423 (530)	767 (169)
	Summer	Weekday	15,730 (6,829)	7,859 (3,340)	2,160 (929)	0 (0)
		Weekend	3,542 (898)	578 (155)	265 (69)	1,359 (365)
		Summer Total	19,271 (6,888)	8,437 (3,343)	2,425 (931)	1,359 (365)
	Winter	Weekday	5,796 (2,768)	6,804 (3,250)	504 (241)	1,008 (481)
		Weekend	1,786 (649)	21 (8)	0 (0)	145 (54)
		Winter Total	7,582 (2,843)	6,825 (3,250)	504 (241)	1,153 (484)
	Access Total		56,499 (9,886)	54,812 (12,053)	5,353 (1,098)	3,279 (629)
Shoreline	Spring	Weekday	82 (57)	480 (336)	0 (0)	0 (0)
		Weekend	2,238 (1,291)	2,251 (1,299)	0 (0)	76 (44)
		Spring Total	2,320 (1,292)	2,731 (1,341)	0 (0)	76 (44)
	Summer	Weekday	0 (0)	0 (0)	0 (0)	542 (379)
		Weekend	1,418 (1,416)	0 (0)	0 (0)	235 (235)
		Summer Total	1,418 (1,416)	0 (0)	0 (0)	777 (446)
	Winter	Weekday	691 (483)	0 (0)	0 (0)	23 (15)
		Weekend	62 (44)	0 (0)	0 (0)	182 (128)
		Winter Total	754 (485)	0 (0)	0 (0)	204 (129)
	Shoreline Total		4,492 (1,978)	2,731 (1,341)	0 (0)	1,058 (466)
Agua Fria	March 1 – June 15	Weekday	568 (281)	2,859 (1,425)	0 (0)	61 (30)
	March 1 – June 15	Weekend	552 (225)	2,241 (912)	67 (27)	111 (45)
	Agua Fria Total		1,120 (360)	5,100 (1,692)	67 (27)	172 (54)
Lake Total			62,112 (10,089)	62,643 (12,244)	5,419 (1,099)	4,509 (785)

Appendix 5g (cont).

Survey Type	Season	Day of Week	Common Carp	Crappie	Sunfish	Total
Access	Spring	Weekday	136 (46)	2,273 (778)	272 (91)	53,147 (17,909)
		Weekend	39 (10)	7,407 (1,882)	2,802 (688)	32,166 (7,967)
		Spring Total	175 (47)	9,680 (2,037)	3,073 (694)	85,314 (19,602)
	Summer	Weekday	0 (0)	3,022 (1,284)	951 (418)	29,722 (12,776)
		Weekend	0 (0)	105 (28)	2,320 (612)	8,170 (2,116)
		Summer Total	0 (0)	3,127 (1,285)	3,271 (741)	37,892 (12,952)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	14,112 (6,740)
		Weekend	0 (0)	0 (0)	0 (0)	1,953 (709)
		Winter Total	0 (0)	0 (0)	0 (0)	16,065 (6,777)
	Access Total		175 (47)	12,808 (2,408)	6,345 (1,015)	139,270 (24,452)
Shoreline	Spring	Weekday	0 (0)	0 (0)	2,642 (1,861)	3,204 (2,254)
		Weekend	279 (161)	0 (0)	607 (349)	5,450 (3,144)
		Spring Total	279 (161)	0 (0)	3,249 (1,894)	8,654 (3,868)
	Summer	Weekday	0 (0)	0 (0)	0 (0)	542 (379)
		Weekend	0 (0)	0 (0)	2,330 (2,327)	3,983 (3,978)
		Summer Total	0 (0)	0 (0)	2,330 (2,327)	4,525 (3,996)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	714 (499)
		Weekend	17 (12)	0 (0)	25 (17)	286 (201)
		Winter Total	17 (12)	0 (0)	25 (17)	1,000 (538)
	Shoreline Total		295 (161)	0 (0)	5,604 (3,000)	14,181 (5,587)
Agua Fria	March 1 – June 15	Weekday	0 (0)	201 (100)	129 (64)	3,819 (1,900)
	March 1 – June 15	Weekend	0 (0)	83 (34)	0 (0)	3,054 (1,243)
	Agua Fria Total		0 (0)	284 (105)	129 (64)	6,873 (2,270)
Lake Total			471 (168)	13,091 (2,410)	12,078 (3,168)	160,323 (25,185)

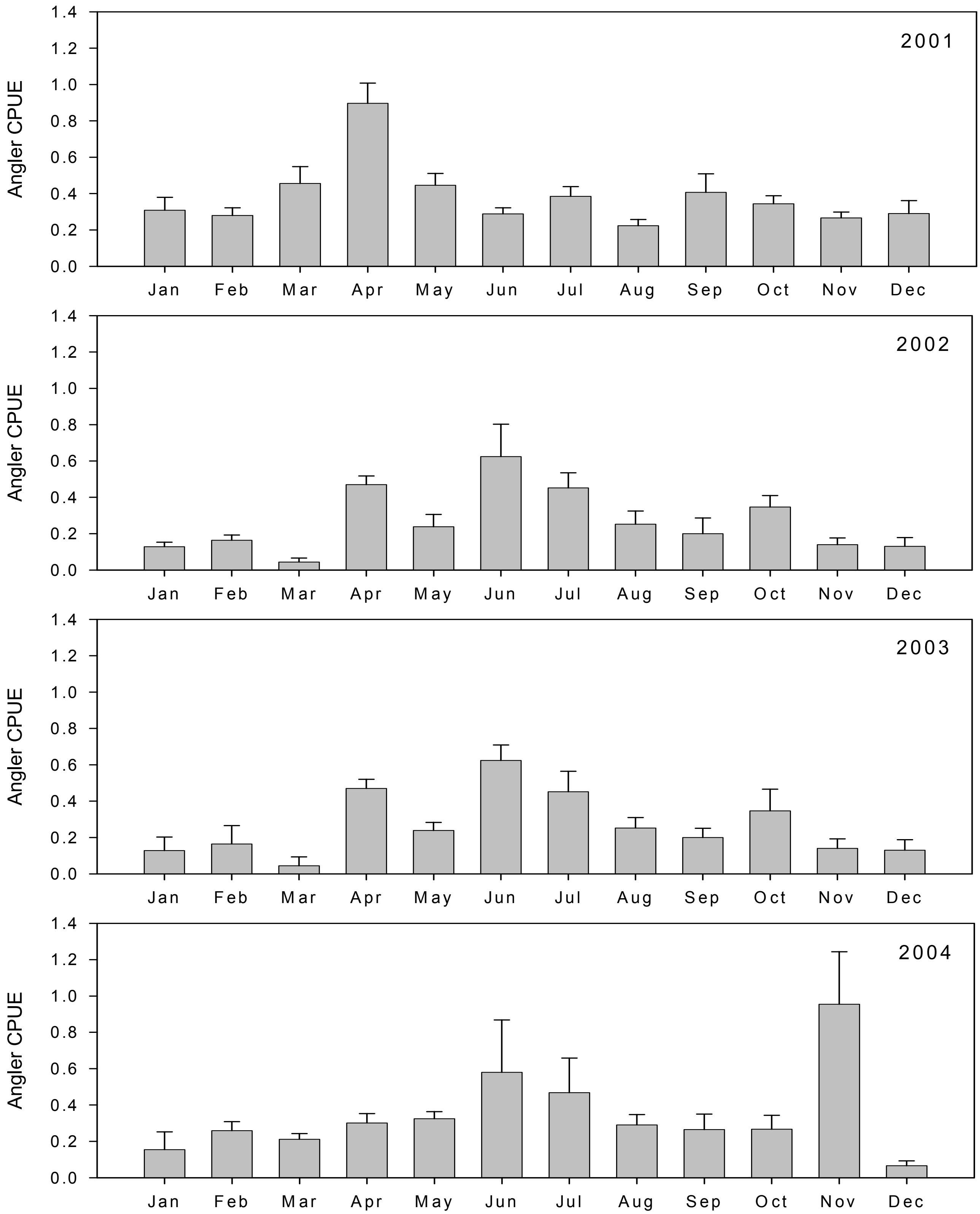
Appendix 5h. Estimates of angler harvest for individual species and survey strata in Lake Pleasant, 2004. Standard errors are in parentheses. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Striped Bass	Catfish
Access	Spring	Weekday	4,460 (1,523)	9,201 (3,099)	0 (0)	0 (0)
		Weekend	2,425 (597)	5,256 (1,312)	1,926 (491)	296 (73)
		Spring Total	6,885 (1,635)	14,458 (3,365)	1,926 (491)	296 (73)
	Summer	Weekday	605 (257)	907 (385)	302 (128)	0 (0)
		Weekend	362 (96)	0 (0)	23 (6)	577 (153)
		Summer Total	966 (274)	907 (385)	325 (129)	577 (153)
	Winter	Weekday	1,512 (722)	4,788 (2,287)	504 (241)	1,008 (481)
		Weekend	0 (0)	0 (0)	0 (0)	0 (0)
		Winter Total	1,512 (722)	4,788 (2,287)	504 (241)	1,008 (481)
	Access Total		9,862 (1,809)	20,152 (4,087)	2,756 (562)	1,881 (511)
Shoreline	Spring	Weekday	0 (0)	480 (336)	0 (0)	0 (0)
		Weekend	955 (551)	1,329 (767)	0 (0)	11 (7)
		Spring Total	955 (551)	1,809 (837)	0 (0)	11 (7)
	Summer	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
		Weekend	0 (0)	0 (0)	0 (0)	235 (235)
		Summer Total	0 (0)	0 (0)	0 (0)	235 (235)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
		Weekend	10 (7)	0 (0)	0 (0)	17 (12)
		Winter Total	10 (7)	0 (0)	0 (0)	17 (12)
	Shoreline Total		965 (551)	1,809 (837)	0 (0)	264 (235)
Agua Fria	March 1 – June 15	Weekday	332 (163)	2,579 (1,286)	0 (0)	29 (14)
	March 1 – June 15	Weekend	334 (136)	1,570 (638)	67 (27)	65 (26)
	Agua Fria Total		666 (212)	4,149 (1,436)	67 (27)	94 (30)
Lake Total			10,994 (1,903)	26,110 (4,412)	2,822 (562)	2,239 (563)

Appendix 5h (cont).

Survey Type	Season	Day of Week	Common Carp	Crappie	Sunfish	Total
Access	Spring	Weekday	0 (0)	136 (46)	0 (0)	13,797 (4,664)
		Weekend	0 (0)	7,370 (1,873)	396 (97)	17,670 (4,436)
		Spring Total	0 (0)	7,506 (1,874)	396 (97)	31,466 (6,437)
	Summer	Weekday	0 (0)	3,023 (1,284)	0 (0)	4,836 (2,055)
		Weekend	0 (0)	0 (0)	46 (12)	1,008 (267)
		Summer Total	0 (0)	3,023 (1,284)	46 (12)	5,844 (2,072)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	7,812 (3,731)
		Weekend	0 (0)	0 (0)	0 (0)	0 (0)
		Winter Total	0 (0)	0 (0)	0 (0)	7,812 (3,731)
	Access Total		0 (0)	10,528 (2,272)	442 (98)	45,122 (7,724)
Shoreline	Spring	Weekday	0 (0)	0 (0)	82 (57)	562 (392)
		Weekend	0 (0)	0 (0)	87 (50)	2,383 (1,375)
		Spring Total	0 (0)	0 (0)	169 (76)	2,945 (1,430)
	Summer	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
		Weekend	0 (0)	0 (0)	0 (0)	235 (235)
		Summer Total	0 (0)	0 (0)	0 (0)	235 (235)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	0 (0)
		Weekend	17 (12)	0 (0)	25 (17)	70 (49)
		Winter Total	17 (12)	0 (0)	25 (17)	70 (49)
	Shoreline Total		0 (0)	0 (0)	194 (78)	3,250 (1,450)
Agua Fria	March 1 – June 15	Weekday	0 (0)	201 (100)	65 (32)	3,205 (1,594)
	March 1 – June 15	Weekend	0 (0)	76 (31)	0 (0)	2,111 (859)
	Agua Fria Total		0 (0)	277 (104)	65 (32)	5,316 (1,811)
Lake Total			17 (12)	10,805 (2,274)	700 (129)	53,689 (8,064)

Appendix 6. Mean monthly CPUE with standard error bars for anglers participating in surveys at Lake Pleasant, 2001-2004.



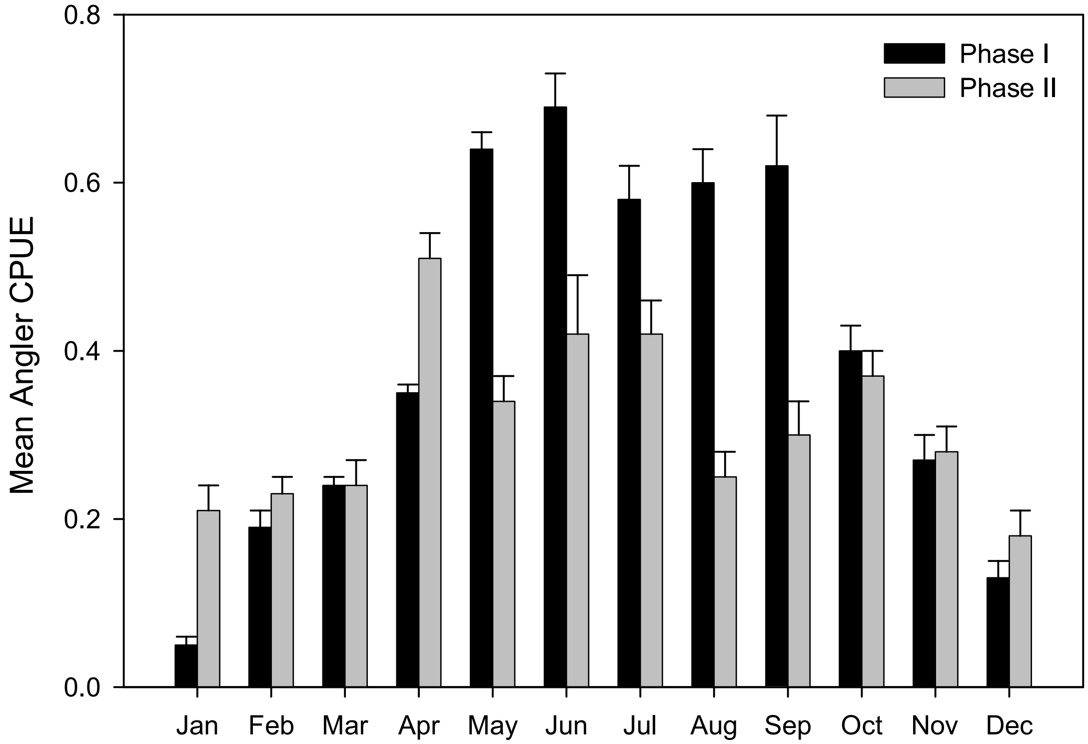
Appendix 7. Mean seasonal catch-per-unit-effort (CPUE) of species caught by anglers targeting that species during 2001-2004 in Lake Pleasant.

	2001			2002			2003			2004		
	Spring	Summer	Winter	Spring	Summer	Winter	Spring	Summer	Winter	Spring	Summer	Winter
LM Bass	0.44(.05)	0.29(.02)	0.28(.04)	0.30(.03)	0.24(.03)	0.12(.02)	0.25(.02)	0.21(.03)	0.19(.04)	0.22(.02)	0.25(.04)	0.16(.08)
White Bass	1.33(.20)	0.71(.19)	0.25(.08)	0.55(.11)	0.90(.29)	0.72(.23)	0.65(.16)	0.05(.04)	0.51(.38)	0.62(.12)	2.00(--)	1.33(--)
ST Bass	0.14(.00)	0.04(.03)	0.25(.25)	--(--)	0.00(.00)	0.00(.00)	0.00(.00)	0.00(.00)	--(--)	--(--)	0.00(.00)	0.00(.00)
Catfish	0.16(.04)	0.18(.06)	0.18(.00)	0.00(.00)	0.12(.04)	0.14(.06)	0.00(.00)	0.07(.02)	--(--)	0.04(.02)	0.04(.04)	--(--)
Sunfish	0.00(.00)	0.21(.12)	--(--)	--(--)	0.61(.28)	--(--)	0.42(--)	2.11 (.49)	--(--)	0.00(.00)	.08(.05)	--(--)
Crappie	0.01(.01)	0.56(.38)	--(--)	0.17(.11)	0.06(.04)	--(--)	0.00(.00)	0.00(.00)	0.00(.00)	0.16(.08)	0.00(.00)	--(--)
Multiple	0.39(.09)	0.21(.04)	0.15(.04)	0.22(.04)	0.57(.18)	0.08(.02)	0.15(.03)	0.31(.07)	0.33(.07)	0.22(.04)	0.32(.11)	0.29(.12)

Appendix 8. Total estimated angling pressure (hours) on Lake Pleasant, 1987-1989. Estimates are derived from only completed trip interviews and are therefore conservative estimates of pressure. Also, 1987 and 1989 are only partial year estimates, since surveys were not conducted throughout each year. Spring is February-May, summer is June–October, and winter is November–January.

			1987 (Sept. – Dec.)		1988 (Full Year)		1989 (Jan. – Aug.)	
Method	Time of Year	Day of Week	Angler Hours	SE	Angler Hours	SE	Angler Hours	SE
Access	Spring	weekday	--	--	127,869	18,187	88,374	18,094
	Spring	weekend/holiday	--	--	100,295	14,691	175,742	73,289
	Summer	weekday	38,843	17,349	66,617	9,020	46,752	11,953
	Summer	weekend/holiday	70,242	54,139	102,833	15,824	45,563	6,818
	Winter	weekday	15,942	6,888	23,998	10,048	14,007	8,946
	Winter	weekend/holiday	16,135	6,173	25,563	13,452	--	--
Total Pressure			141,162	57,598	447,175	34,063	370,437	77,253

Appendix 9. Mean monthly CPUE with standard error bars for anglers participating in surveys at Lake Pleasant during Phase I and Phase II.



Appendix 10. Mean seasonal catch-per-unit-effort (CPUE) of species caught by anglers targeting that species during Phase I and Phase II in Lake Pleasant. Asterisks indicate values that are significantly higher within a season (t-test; $P < 0.05$).

	Spring		Summer		Winter		Total	
	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II
Largemouth Bass	0.21 (0.01)	0.30 (0.02)*	0.28 (0.01)	0.26 (0.02)	0.12 (0.01)	0.21 (0.02)*	0.23 (0.01)	0.27 (0.01)*
White Bass	0.53 (0.04)	0.87 (0.09)*	0.38 (0.05)	0.63 (0.13)	0.30 (0.08)	0.40 (0.09)	0.49 (0.03)	0.75 (0.07)*
Striped Bass	-- (--)	0.06 (0.03)	-- (--)	0.02 (0.02)	-- (--)	0.11 (0.11)	-- (--)	0.05 (0.03)
Catfish	0.06 (0.01)	0.06 (0.02)	0.25 (0.03)*	0.12 (0.02)	0.10 (0.03)	0.13 (0.04)	0.16 (0.02)	0.11 (0.02)
Sunfish	1.45 (0.16)*	0.08 (0.08)	1.94 (0.20)*	1.04 (0.24)	2.06 (1.35)	-- (--)	1.69 (0.13)*	0.95 (0.22)
Crappie	0.26 (0.06)	0.07 (0.03)	0.31 (0.25)	0.15 (0.09)	0.05 (0.03)	-- (--)	0.26 (0.05)	0.10 (0.04)
Multiple	0.33 (0.01)*	0.23 (0.03)	0.63 (0.04)*	0.35 (0.06)	0.14 (0.02)	0.18 (0.03)	0.40 (0.01)*	0.27 (0.03)

Appendix 11a. Estimates of angler catch for individual species and survey strata in Lake Pleasant, 1987. Standard errors are in parentheses. Data were only collected during September – December. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Sunfish	Catfish
Access	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Spring Total	-- (--)	-- (--)	-- (--)	-- (--)
	Summer	Weekday	5,542 (1,822)	1,800 (678)	3,806 (1,250)	1,513 (464)
	(Sept. – Oct.)	Weekend	6,530 (3,969)	1,450 (917)	15,179 (8,825)	2,716 (1,500)
		Summer Total	12,073 (4,368)	3,249 (1,141)	18,985 (8,914)	4,229 (1,570)
	Winter	Weekday	866 (250)	319 (89)	433 (151)	91 (29)
	(Nov. – Dec)	Weekend	1,051 (329)	1,311 (468)	1,244 (414)	419 (148)
		Winter Total	1,916 (413)	1,630 (477)	1,677 (4,415)	510 (150)
Lake Total			13,989 (4,387)	4,879 (1,236)	20,662 (8,925)	4,739 (1,577)

Survey Type	Season	Day of Week	Crappie	Common Carp	Yellow Bullhead	Total
Access	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Spring Total	-- (--)	-- (--)	-- (--)	-- (--)
	Summer	Weekday	80 (28)	32 (16)	0 (0)	12,773 (4,157)
	(Sept. – Oct.)	Weekend	141 (87)	28 (13)	134 (74)	26,178 (15,360)
		Summer Total	220 (91)	60 (21)	134 (74)	38,950 (15,913)
	Winter	Weekday	11 (6)	137 (68)	0 (0)	1,856 (506)
	(Nov. – Dec)	Weekend	41 (15)	6 (3)	0 (0)	4,073 (1,352)
		Winter Total	53 (16)	143 (68)	0 (0)	5,929 (1,443)
Lake Total			273 (93)	203 (71)	134 (177)	44,880 (15,978)

Appendix 11b. Estimates of angler harvest for individual species and survey strata in Lake Pleasant, 1987. Standard errors are in parentheses. Data were only collected during September – December. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Sunfish	Catfish
Access	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Spring Total	-- (--)	-- (--)	-- (--)	-- (--)
	Summer	Weekday	2,341 (783)	1,298 (498)	733 (297)	884 (275)
	(Sept. – Oct.)	Weekend	3,096 (1,906)	725 (459)	1,253 (684)	1,210 (646)
		Summer Total	5,437 (2,061)	2,023 (677)	1,985 (746)	2,094 (702)
	Winter	Weekday	410 (116)	273 (78)	251 (124)	68 (22)
	(Nov. – Dec)	Weekend	641 (216)	1,029 (365)	270 (101)	276 (102)
		Winter Total	1,051 (245)	1,301 (373)	520 (160)	345 (104)
Lake Total			6,489 (2,075)	3,324 (773)	2,506 (763)	2,439 (709)

Survey Type	Season	Day of Week	Crappie	Common Carp	Yellow Bullhead	Total
Access	Spring	Weekday	-- (--)	-- (--)	-- (--)	-- (--)
		Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Spring Total	-- (--)	-- (--)	-- (--)	-- (--)
	Summer	Weekday	48 (15)	0 (0)	0 (0)	5,303 (1,750)
	(Sept. – Oct.)	Weekend	0 (0)	14 (8)	42 (74)	6,298 (3,652)
		Summer Total	48 (15)	14 (8)	42 (74)	11,601 (4,050)
	Winter	Weekday	11 (6)	0 (0)	0 (0)	1,014 (294)
	(Nov. – Dec)	Weekend	41 (15)	0 (0)	0 (0)	2,257 (776)
		Winter Total	53 (16)	0 (0)	0 (0)	3,271 (830)
Lake Total			100 (22)	14 (8)	42 (177)	14,872 (4,134)

Appendix 11c. Estimates of angler catch for individual species and survey strata in Lake Pleasant, 1988. Standard errors are in parentheses. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Sunfish	Catfish
Access	Spring	Weekday	13,731 (2,109)	13,326 (2,403)	14,102 (2,293)	1,182 (194)
		Weekend	6,275 (1,062)	10,948 (2,408)	11,422 (2,097)	1,192 (232)
		Spring Total	20,006 (2,361)	24,273 (3,402)	25,525 (3,108)	2,374 (303)
	Summer	Weekday	10,760 (1,972)	5,430 (1,376)	22,164 (3,698)	4,660 (739)
		Weekend	9,150 (1,830)	3,770 (942)	32,732 (6,626)	5,460 (1,084)
		Summer Total	19,910 (2,690)	9,200 (1,668)	54,896 (7,588)	10,119 (1,312)
	Winter	Weekday	2,595 (793)	1,054 (339)	554 (178)	279 (86)
		Weekend	1,261 (522)	150 (67)	419 (203)	636 (275)
		Winter Total	3,857 (949)	1,204 (346)	973 (270)	915 (289)
Lake Total			43,773 (3,703)	34,677 (3,805)	81,394 (8,204)	13,408 (1,377)

Survey Type	Season	Day of Week	Crappie	Common Carp	Yellow Bullhead	Total
Access	Spring	Weekday	5,598 (884)	242 (56)	0 (0)	48,181 (7,435)
		Weekend	2,632 (479)	98 (22)	0 (0)	32,568 (5,931)
		Spring Total	8,230 (1,006)	340 (60)	0 (0)	80,748 (9,511)
	Summer	Weekday	318 (77)	289 (62)	13 (6)	43,634 (7,235)
		Weekend	1,187 (272)	247 (50)	17 (6)	52,563 (10,599)
		Summer Total	1,505 (283)	536 (80)	30 (8)	96,198 (12,833)
	Winter	Weekday	257 (85)	0 (0)	0 (0)	4,738 (1,448)
		Weekend	17 (9)	43 (22)	21 (11)	2,548 (1,059)
		Winter Total	274 (86)	43 (22)	21 (11)	7,286 (1,794)
Lake Total			10,009 (1,048)	919 (103)	52 (14)	184,232 (16,074)

Appendix 11d. Estimates of angler harvest for individual species and survey strata in Lake Pleasant, 1988. Standard errors are in parentheses. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Sunfish	Catfish
Access	Spring	Weekday	5,527 (829)	11,295 (2,113)	4,832 (837)	834 (140)
		Weekend	3,473 (592)	8,684 (1,974)	2,935 (594)	839 (160)
		Spring Total	9,000 (1,018)	19,979 (2,892)	7,767 (1,027)	1,673 (213)
	Summer	Weekday	2,787 (461)	4,015 (1,138)	3,840 (730)	1,805 (295)
		Weekend	2,809 (566)	2,310 (615)	6,240 (1,322)	2,380 (486)
		Summer Total	5,597 (731)	6,325 (1,294)	10,079 (1,510)	4,185 (569)
	Winter	Weekday	1,430 (457)	979 (318)	22 (9)	97 (30)
		Weekend	388 (164)	107 (49)	86 (44)	400 (165)
		Winter Total	1,819 (486)	1,086 (322)	108 (45)	497 (167)
Lake Total			16,415 (1,344)	27,390 (3,184)	17,954 (1,827)	6,356 (630)

Survey Type	Season	Day of Week	Crappie	Common Carp	Yellow Bullhead	Total
Access	Spring	Weekday	4,440 (717)	136 (42)	0 (0)	27,064 (4,268)
		Weekend	1,881 (342)	53 (15)	0 (0)	17,864 (3,374)
		Spring Total	6,321 (795)	188 (45)	0 (0)	44,928 (5,441)
	Summer	Weekday	185 (50)	130 (32)	0 (0)	12,762 (2,268)
		Weekend	280 (66)	98 (23)	8 (4)	14,118 (2,850)
		Summer Total	465 (83)	228 (40)	8 (4)	26,879 (3,642)
	Winter	Weekday	168 (56)	0 (0)	0 (0)	2,697 (857)
		Weekend	17 (9)	21 (11)	0 (0)	1,019 (406)
		Winter Total	185 (57)	21 (11)	0 (0)	3,716 (949)
Lake Total			6,971 (801)	437 (61)	8 (4)	75,523 (6,616)

Appendix 11e. Estimates of angler catch for individual species and survey strata in Lake Pleasant, 1989. Standard errors are in parentheses. Data were only collected during January - August. Spring is February-May, summer is June–October, and winter is November–January.

Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Sunfish	Catfish
Access	Spring	Weekday	14,044 (2,555)	4,376 (799)	22,535 (4,128)	2,846 (545)
	Feb. – May	Weekend	8,119 (3,196)	6,674 (2,710)	23,361 (9,665)	3,643 (1,494)
		Spring Total	22,163 (4,092)	11,050 (2,825)	45,896 (10,510)	6,488 (1,591)
	Summer	Weekday	10,158 (2,807)	266 (68)	15,296 (3,264)	3,688 (779)
	Jun.– Aug.	Weekend	3,420 (2,396)	90 (63)	9,630 (6,748)	3,870 (2,710)
		Summer Total	13,578 (3,691)	356 (93)	24,926 (7,496)	7,558 (2,819)
	Winter	Weekday	378 (293)	42 (33)	0 (0)	0 (0)
	Jan.	Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Winter Total	378 (293)	42 (33)	0 (0)	0 (0)
Lake Total			36,119 (5,518)	11,448 (2,827)	81,394 (12,909)	14,047 (3,237)

Survey Type	Season	Day of Week	Crappie	Common Carp	Yellow Bullhead	Total
Access	Spring	Weekday	1,136 (223)	267 (57)	0 (0)	45,204 (8,030)
	Feb. – May	Weekend	2,550 (1,164)	836 (364)	36 (18)	45,220 (18,196)
		Spring Total	3,686 (1,185)	1,104 (368)	36 (18)	90,424 (19,889)
	Summer	Weekday	83 (21)	157 (42)	0 (0)	29,647 (6,568)
	Jun.– Aug.	Weekend	225 (163)	135 (103)	0 (0)	17,370 (12,159)
		Summer Total	308 (164)	292 (111)	0 (0)	47,017 (13,819)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	420 (326)
	Jan.	Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Winter Total	0 (0)	0 (0)	0 (0)	420 (326)
Lake Total			3,993 (1,196)	1,396 (385)	36 (18)	137,861 (24,221)

Appendix 11f. Estimates of angler harvest for individual species and survey strata in Lake Pleasant, 1989. Standard errors are in parentheses. Data were only collected during January - August. Spring is February-May, summer is June–October, and winter is November–January.

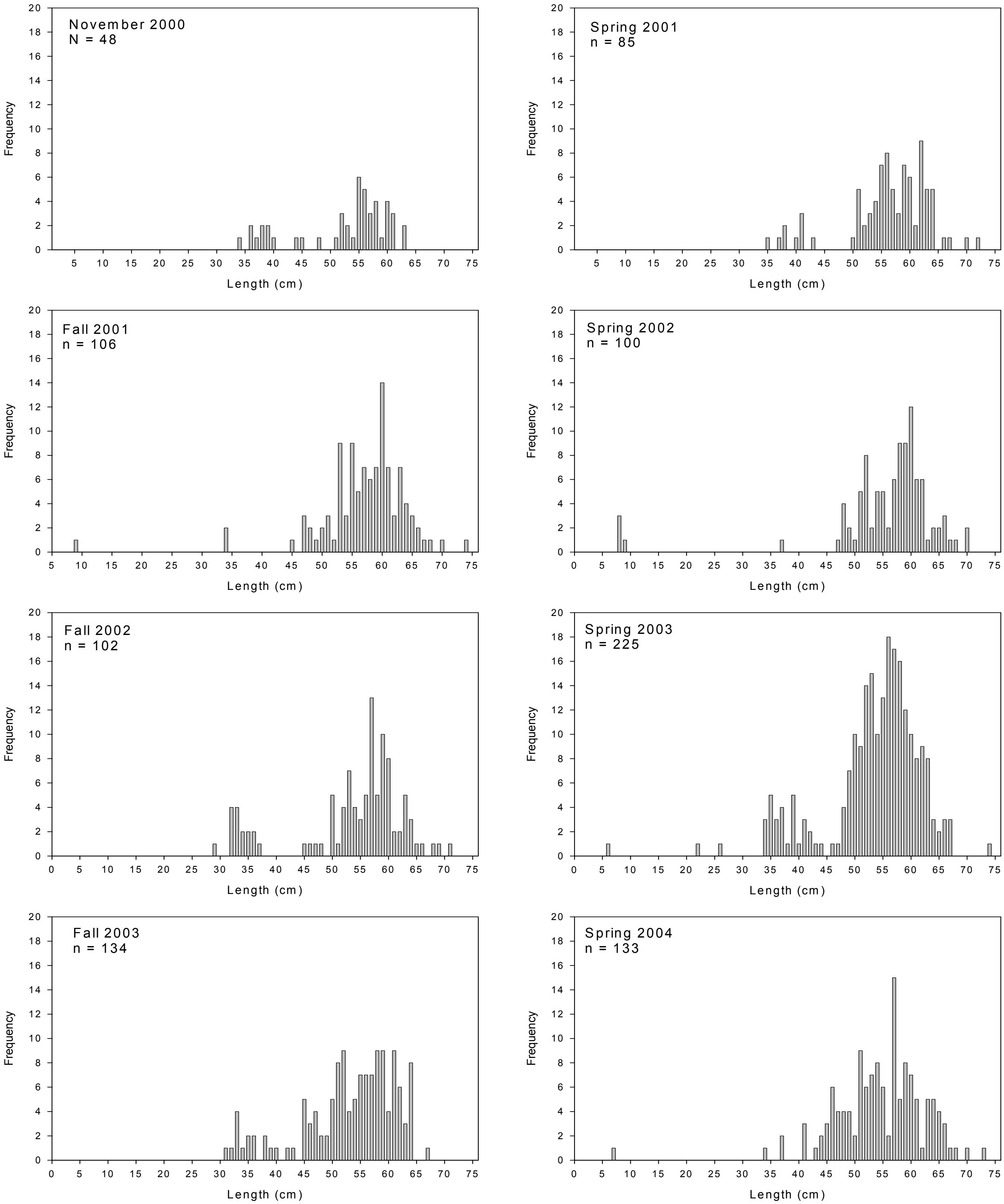
Survey Type	Season	Day of Week	Largemouth Bass	White Bass	Sunfish	Catfish
Access	Spring	Weekday	4,518 (803)	3,860 (712)	8,012 (1,493)	1,718 (343)
	Feb. – May	Weekend	2,814 (1,102)	5,869 (2,395)	4,506 (1,896)	2,352 (963)
		Spring Total	7,332 (1,363)	9,729 (2,498)	12,519 (2,413)	4,070 (1,022)
	Summer	Weekday	1,380 (305)	170 (48)	2,076 (485)	1,991 (456)
	Jun.– Aug.	Weekend	450 (343)	45 (34)	2,385 (1,685)	1,980 (1,390)
		Summer Total	1,830 (459)	215 (59)	4,461 (1,754)	3,971 (1,463)
	Winter	Weekday	84 (66)	42 (33)	0 (0)	0 (0)
	Jan.	Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Winter Total	84 (66)	42 (33)	0 (0)	0 (0)
Lake Total			9,246 (1,440)	9,986 (2,499)	16,980 (2,983)	8,041 (1,785)

Survey Type	Season	Day of Week	Crappie	Common Carp	Yellow Bullhead	Total
Access	Spring	Weekday	832 (172)	158 (38)	0 (0)	19,098 (3,406)
	Feb. – May	Weekend	1,881 (857)	437 (196)	0 (0)	17,859 (7,112)
		Spring Total	2,713 (874)	595 (199)	0 (0)	36,957 (7,886)
	Summer	Weekday	52 (16)	124 (38)	0 (0)	5,793 (1,221)
	Jun.– Aug.	Weekend	90 (63)	0 (0)	36 (18)	4,950 (3,476)
		Summer Total	142 (65)	124 (38)	36 (18)	10,743 (3,684)
	Winter	Weekday	0 (0)	0 (0)	0 (0)	126 (100)
	Jan.	Weekend	-- (--)	-- (--)	-- (--)	-- (--)
		Winter Total	0 (0)	0 (0)	0 (0)	126 (100)
Lake Total			2,854 (876)	719 (203)	36 (18)	47,826 (8,704)

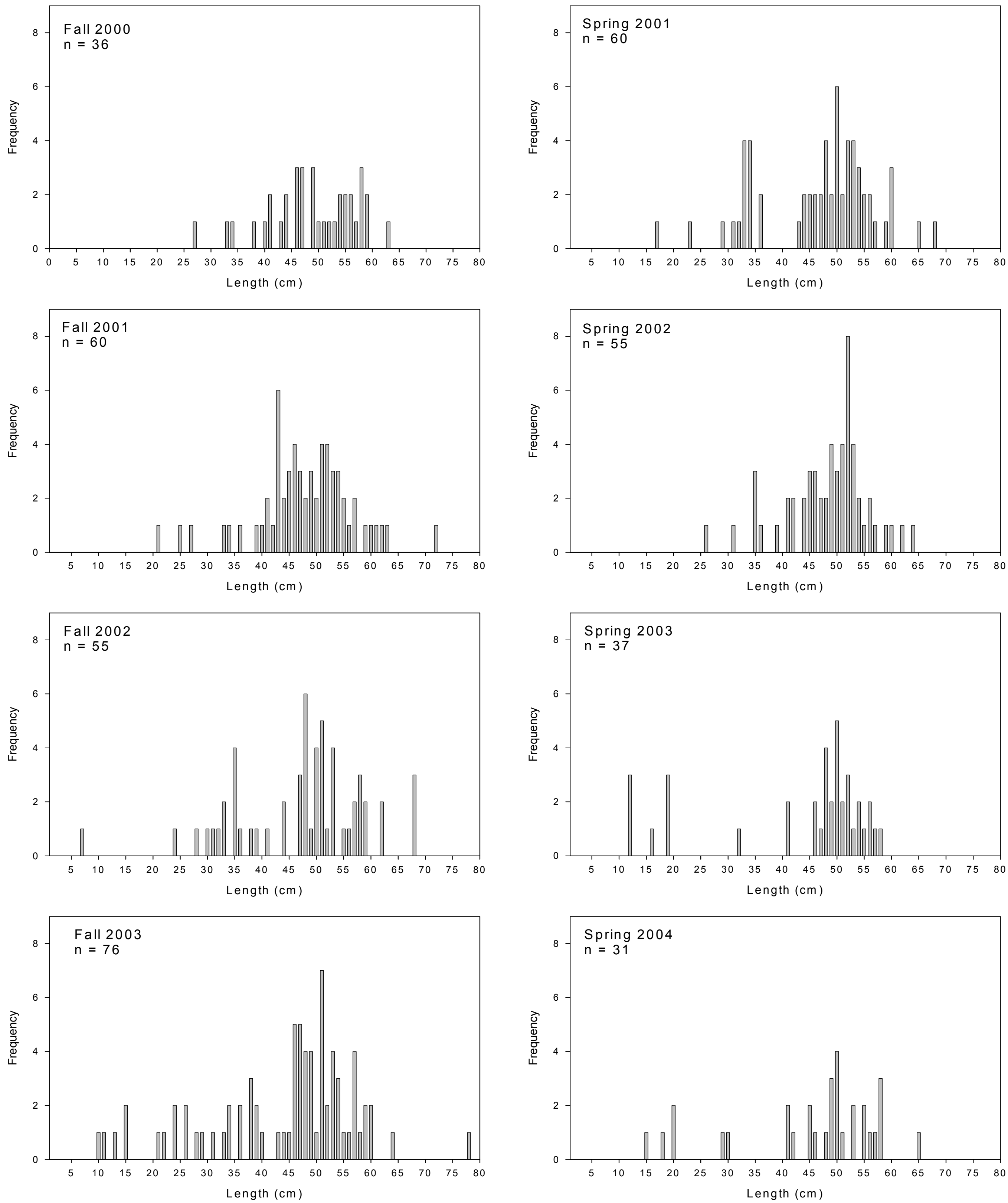
Appendix 12. Number of each species caught, using gill nets and electrofishing, during each sampling trip of Phase II.

	Spring				Fall				
	2001	2002	2003	2004	2000	2001	2002	2003	Total
Common Carp *Cyprinus carpio*	85	102	363	140	48	107	103	136	1084
Red Shiner *Cyprinella lutrensis*	-	-	-	-	3	-	-	-	3
Threadfin Shad *Dorosoma petenense*	31	40	1452	1211	521	865	3297	1593	9010
Channel Catfish *Ictalurus punctatus*	61	56	37	33	36	61	56	84	424
Green Sunfish *Lepomis cyanellus*	50	309	57	147	5	46	193	99	906
Bluegill *Lepomis macrochirus*	137	93	212	153	95	136	158	450	1434
Redear Sunfish *Lepomis microlophus*	1	9	50	24	-	4	31	20	139
Sunfish Hybrid *Lepomis spp.*	13	41	160	3	2	6	8	11	244
Largemouth Bass *Micropterus salmoides*	282	159	419	274	97	250	244	580	2305
White Bass *Morone chrysops*	201	435	310	144	213	462	538	591	2894
Striped Bass *Morone saxatilis*	23	36	35	35	15	27	38	69	278
Golden Shiner *Notemigonus crysoleucas*	1	-	4	-	-	2	3	23	33
White Crappie *Pomoxis annularis*	6	1	-	-	-	-	-	1	8
Black Crappie *Pomoxis nigromaculatus*	3	-	9	4	4	21	9	58	108
Flathead Catfish *Pylodictis olivaris*	5	4	4	5	1	1	7	21	48
Tilapia *Tilapia spp.*	2	-	4	-	-	3	1	29	39
Total (by sampling trip)	901	1285	3116	2173	1040	1991	4686	3765	18957

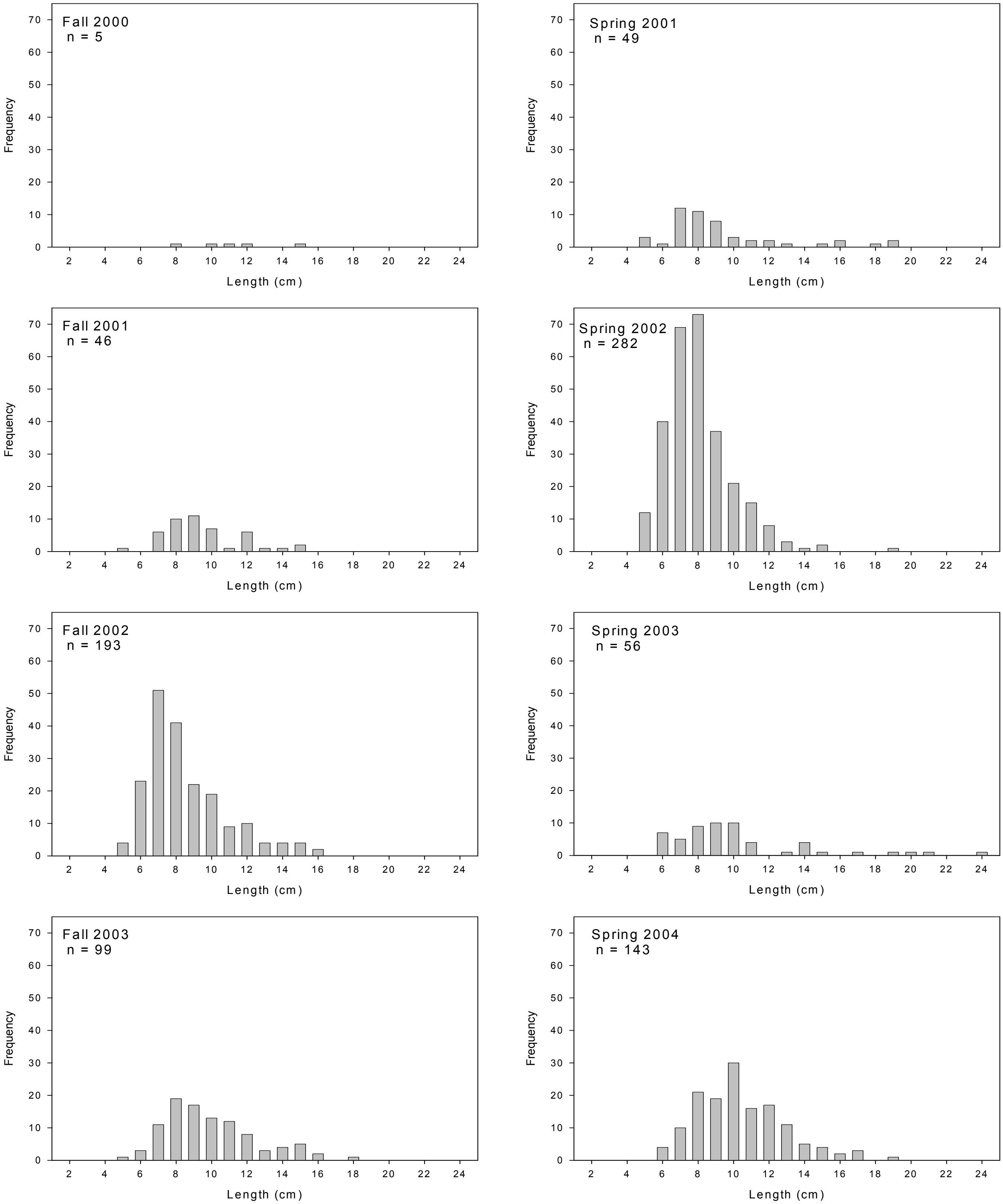
Appendix 13a. Length-frequency histogram of common carp (*Cyprinus carpio*) collected from Lake Pleasant during 2000-2004 using gill netting and electrofishing.



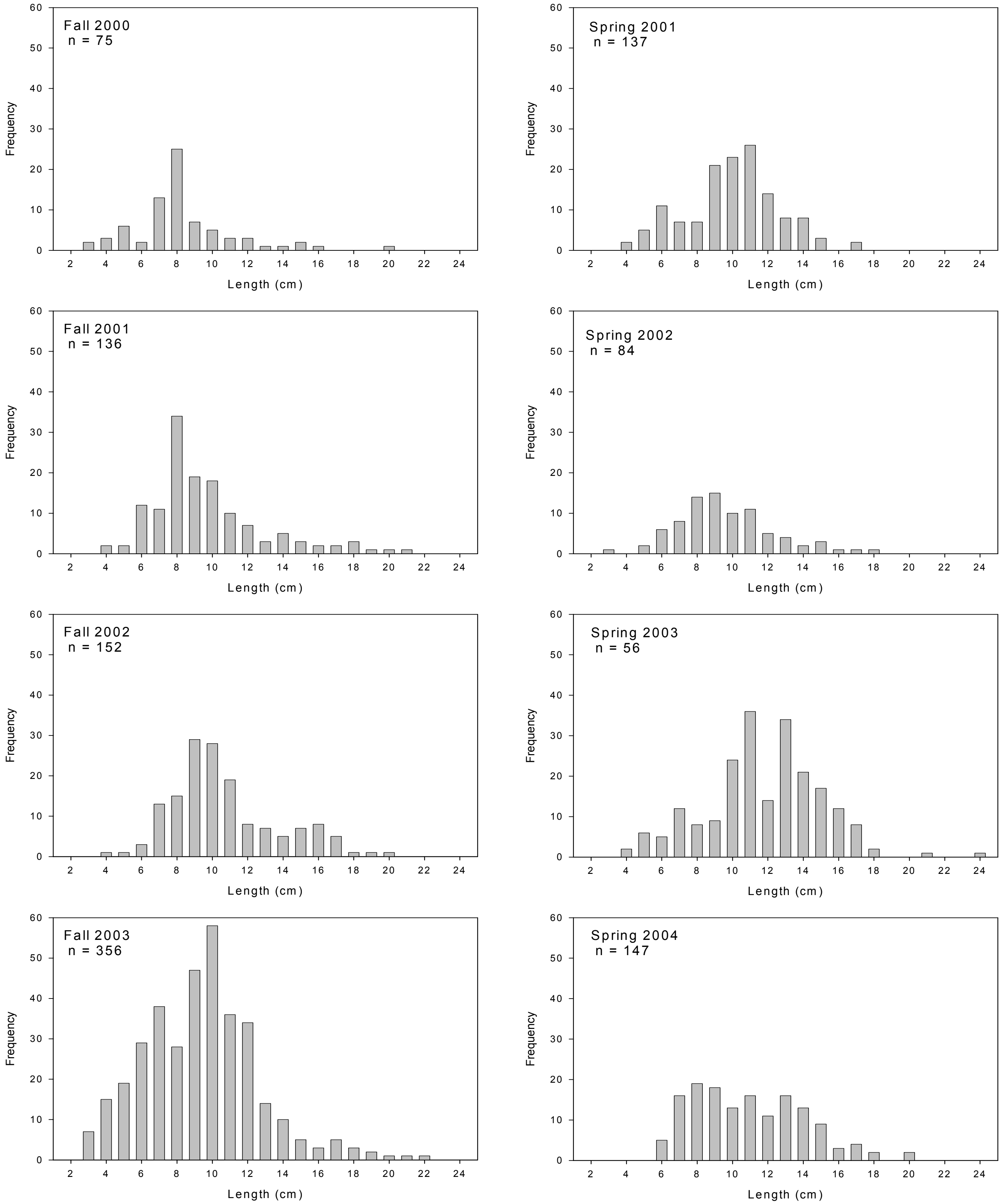
Appendix 13b. Length-frequency histogram of channel catfish (*Ictalurus punctatus*) collected from Lake Pleasant during 2000-2004 using gill netting and electrofishing.



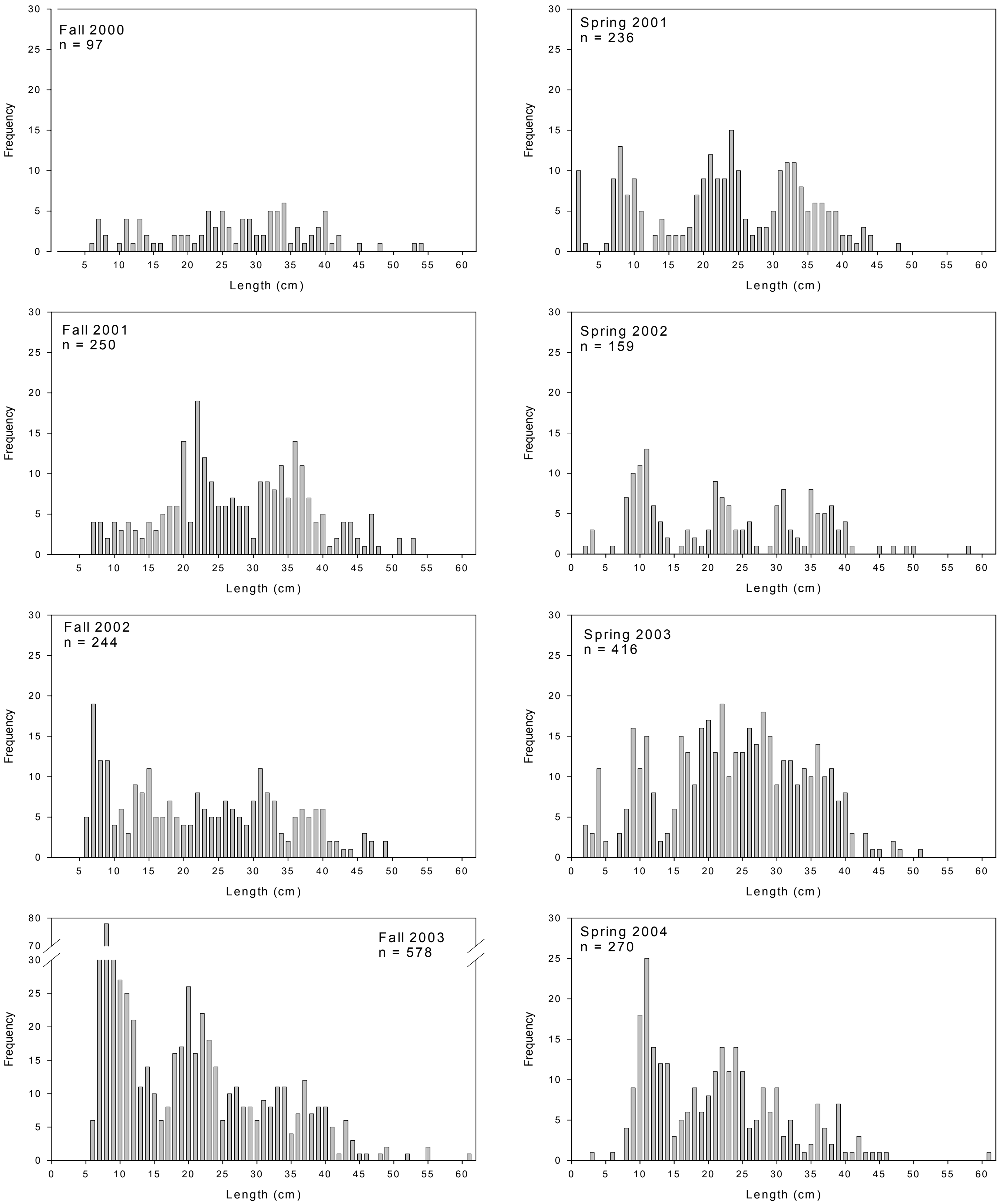
Appendix 13c. Length-frequency histogram of green sunfish (*Lepomis cyanellus*) collected from Lake Pleasant during 2000-2004 using gill netting and electrofishing.



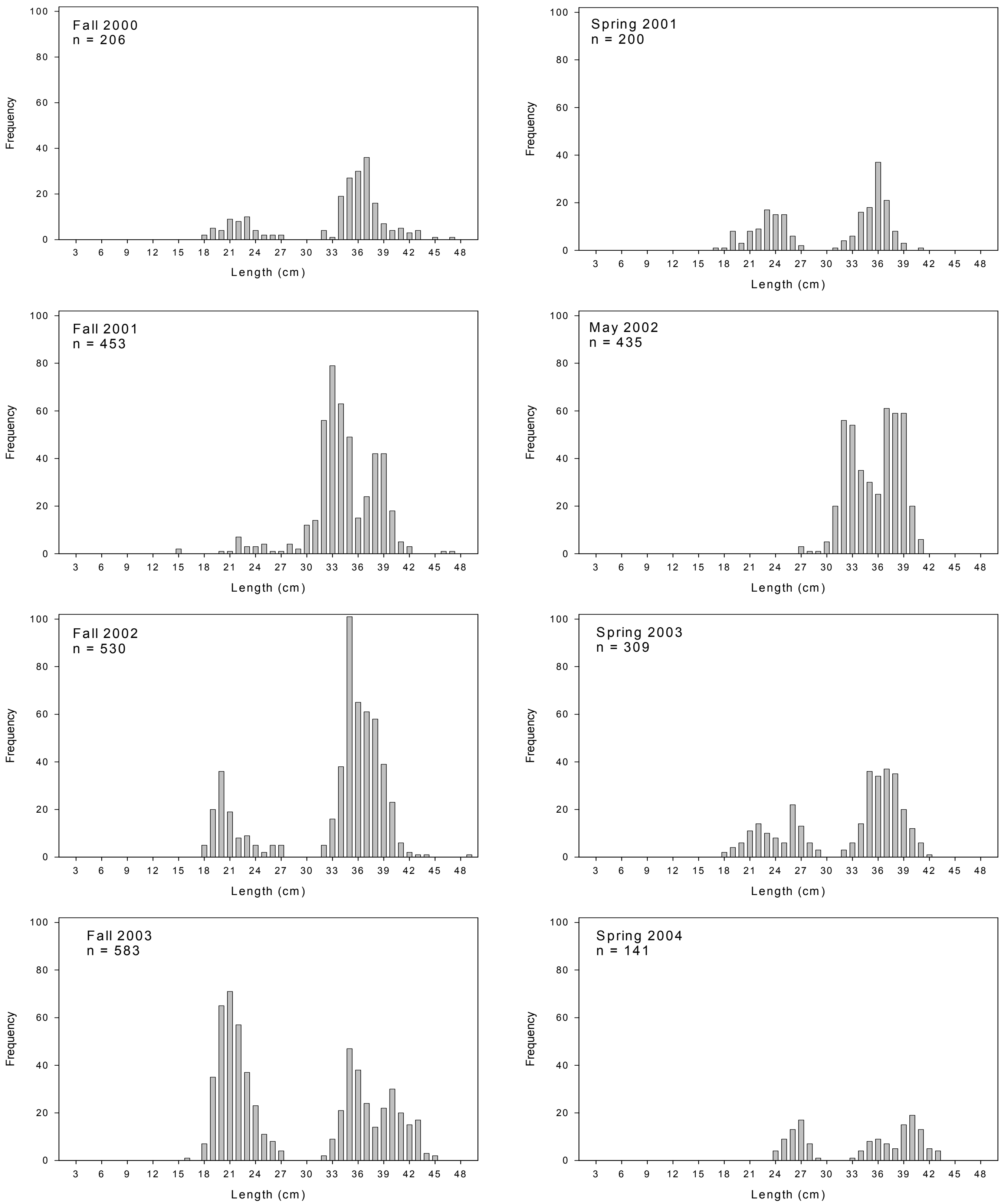
Appendix 13d. Length-frequency histogram of bluegill (*Lepomis macrochirus*) collected from Lake Pleasant during 2000-2004 using gill netting and electrofishing.



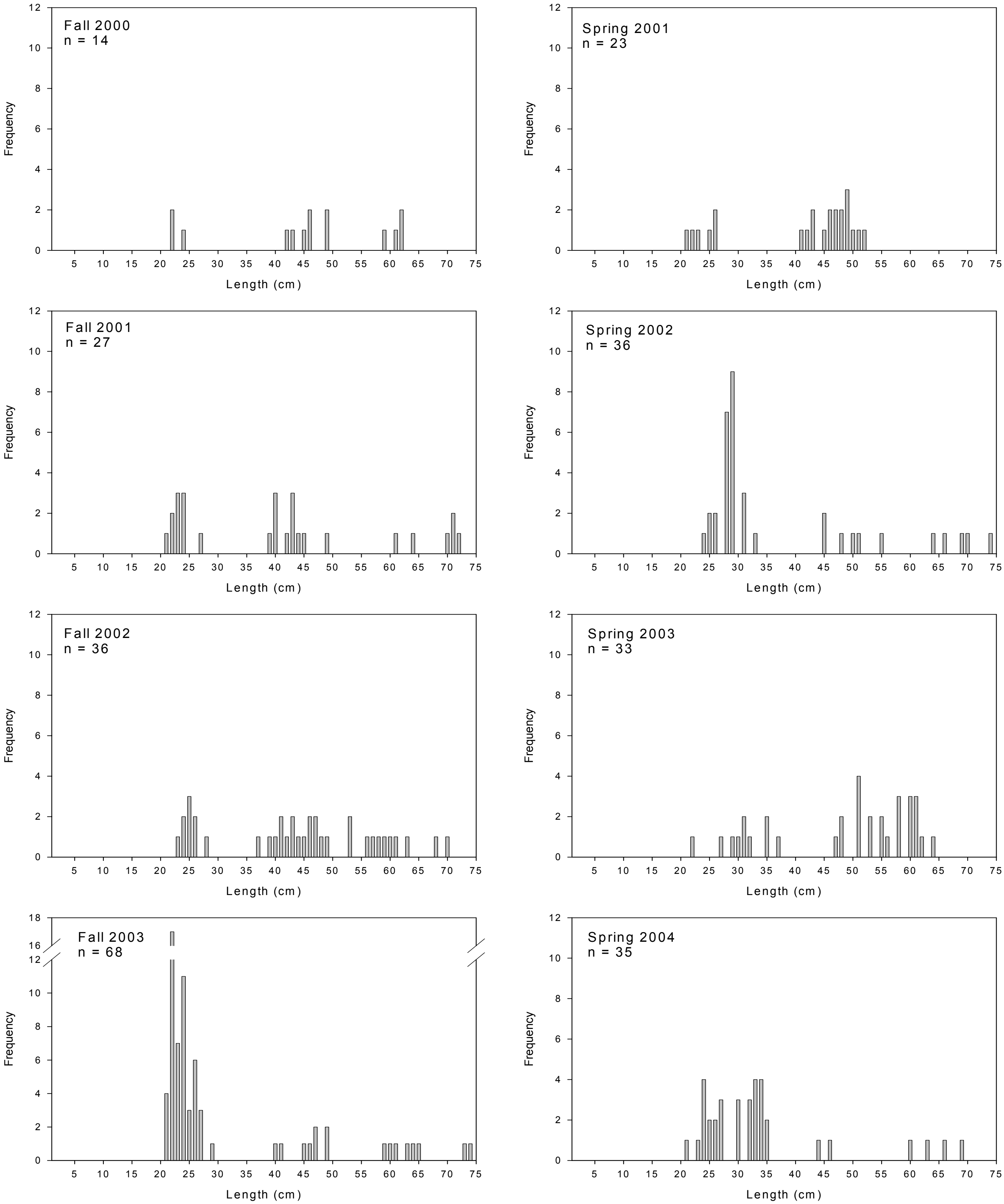
Appendix 13e. Length-frequency histogram of largemouth bass (*Micropterus salmoides*) collected from Lake Pleasant during 2000-2004 using gill netting and electrofishing.



Appendix 13f. Length-frequency histogram of white bass (*Morone chrysops*) collected from Lake Pleasant during 2000-2004 using gill netting and electrofishing.



Appendix 13g. Length-frequency histogram of striped bass (*Morone saxatilis*) collected from Lake Pleasant during 2000-2004 using gill netting and electrofishing.



Appendix 14. Relative stock density (RSD) of incremental length categories of primary sportfish species found in Lake Pleasant during 2000-2004. Fish were collected with a combination of gill netting and electrofishing. S = stock; Q = quality; P = preferred; M = memorable; T = trophy (Willis et al. 1993).

Fall	2000				2001				2002				2003			
	S-Q	Q-P	P-M	M-T	S-Q	Q-P	P-M	M-T	S-Q	Q-P	P-M	M-T	S-Q	Q-P	P-M	M-T
Common Carp	19	15	65	0	2	12	80	6	16	14	67	4	11	30	58	1
Channel Catfish	11	86	3	0	7	86	5	2	23	68	9	0	22	75	2	2
Green Sunfish	80	20	0	0	95	5	0	0	95	5	0	0	90	10	0	0
Sunfish Hybrid	0	100	0	0	100	0	0	0	67	17	17	0	50	40	10	0
Bluegill	92	6	2	0	88	10	2	0	83	16	1	0	92	7	1	0
Redear Sunfish	0	0	0	0	0	0	100	0	37	20	43	0	53	29	18	0
Largemouth Bass	42	35	21	3	45	36	18	2	40	37	23	0	55	27	17	2
White Bass	14	10	57	19	2	4	69	24	17	5	54	25	40	14	24	21
Striped Bass	64	36	0	0	65	35	0	0	59	41	0	0	50	50	0	0
Black Crappie	25	0	75	0	0	15	85	0	0	33	67	0	4	71	25	0
Flathead Catfish	0	100	0	0	0	100	0	0	57	43	0	0	29	62	10	0

Spring	2001				2002				2003				2004			
	S-Q	Q-P	P-M	M-T	S-Q	Q-P	P-M	M-T	S-Q	Q-P	P-M	M-T	S-Q	Q-P	P-M	M-T
Common Carp	6	14	75	5	1	24	71	4	10	24	63	3	2	33	59	5
Channel Catfish	22	74	3	0	9	87	4	0	3	97	0	0	7	89	4	0
Green Sunfish	82	18	0	0	98	2	0	0	86	7	7	0	92	8	0	0
Sunfish Hybrid	33	0	58	0	87	7	7	0	90	8	2	0	100	0	0	0
Bluegill	96	4	0	0	91	9	0	0	78	21	1	0	84	14	2	0
Redear Sunfish	0	0	100	0	44	11	44	0	55	34	11	0	30	48	22	0
Largemouth Bass	48	39	13	0	39	40	19	1	54	32	14	1	64	23	12	1
White Bass	15	28	52	6	0	1	66	33	12	22	42	24	0	36	21	43
Striped Bass	88	12	0	0	53	47	0	0	33	67	0	0	82	18	0	0
Black Crappie	50	0	50	0	0	0	0	0	14	29	57	0	0	50	50	0
Flathead Catfish	80	20	0	0	0	100	0	0	0	100	0	0	20	80	0	0

Appendix 15. Mean relative weight (W_r) of each incremental length category of primary sportfish species found in Lake Pleasant during 2000-2004. Standard error is in parentheses. Fish were collected using a combination of gill netting and electrofishing. Standard error is in parentheses. S = stock; Q = quality; P = preferred; M = memorable; and T = trophy (Willis et al. 1993).

Fall	2000				2001				2002				2003			
	S-Q	Q-P	P-M	M-T	S-Q	Q-P	P-M	M-T	S-Q	Q-P	P-M	M-T	S-Q	Q-P	P-M	M-T
Common Carp	97 (2)	100 (4)	101 (2)		94 (3)	92 (1)	100 (1)	94 (4)	97 (3)	102 (5)	95 (1)	94 (3)	93 (2)	92 (1)	90 (1)	97
Channel Catfish	92 (4)	105 (2)	95		88 (5)	100 (1)	103 (4)	104	95 (7)	93 (2)	91 (5)		92 (9)	95 (2)	96	102
Green Sunfish	86 (3)	87			93 (6)	98 (12)			73 (2)	89 (6)			89 (3)	87 (3)		
Sunfish Hybrid		84 (4)			106 (5)				82 (9)	80	104		80 (5)	90 (2)	65	
Bluegill	86 (1)	74 (9)	110		88 (2)	78 (3)	90 (9)		80 (3)	86 (2)	83		77 (1)	83 (1)	74 (12)	
Redear Sunfish							91 (4)		82 (3)	83 (3)	88 (3)		77 (4)	82 (2)	84 (4)	
Largemouth Bass	86 (2)	88 (1)	90 (3)	84 (16)	81 (1)	87 (1)	90 (1)	87 (3)	85 (2)	86 (1)	88 (2)		81 (1)	88 (1)	91 (1)	106
White Bass	95 (2)	91 (2)	96 (1)	91 (2)	98 (9)	87 (3)	95 (1)	102 (1)	96 (2)	91 (2)	95 (1)	88 (1)	83 (1)	86 (1)	98 (1)	97 (1)
Striped Bass	88 (3)	73 (2)			81 (1)	70 (3)			86 (1)	72 (3)			82 (2)	72 (3)		
Black Crappie	121		101 (7)			94 (4)	91 (2)			95 (26)	91 (3)		115 (13)	94 (1)	95 (2)	
Flathead Catfish		99				108			111 (6)	108 (6)			105 (5)	98 (2)	100 (18)	

Spring	2001				2002				2003				2004			
	S-Q	Q-P	P-M	M-T	S-Q	Q-P	P-M	M-T	S-Q	Q-P	P-M	M-T	S-Q	Q-P	P-M	M-T
Common Carp	107(12)	95 (2)	94 (1)	88 (3)	146	90 (1)	94 (1)	104 (7)	97 (1)	89 (1)	88 (1)	89 (2)	101 (12)	91 (1)	89 (1)	90 (2)
Channel Catfish	112 (5)	107(2)	123 (7)		110(22)	106 (2)	118 (8)		106	102 (2)			103 (8)	101 (4)	130	
Green Sunfish	110 (3)	99 (9)			90 (2)	92 (5)			98 (4)	97 (15)	81 (14)		94 (2)	90 (3)		
Sunfish Hybrid	94 (7)		95 (4)		92 (3)	71 (20)	92 (3)		104 (3)	98 (5)	78 (5)		79 (25)			
Bluegill	100 (1)	93 (4)			84 (3)	105(9)			98 (1)	99 (2)	83 (2)		96 (2)	92 (4)	107 (7)	
Redear Sunfish			110		81 (9)	124	71 (14)		88 (3)	96 (3)	96 (2)		100 (11)	86 (3)	93 (9)	
Largemouth Bass	88 (2)	85 (2)	83 (2)		84 (2)	82 (1)	81 (2)	86	89 (1)	82 (1)	82 (1)	96	88 (1)	87 (2)	82 (2)	90
White Bass	97 (2)	96 (1)	87 (1)	80 (3)		86 (2)	86 (1)	84 (1)	94 (5)	94 (1)	90 (1)	83 (1)		89 (1)	92 (1)	90 (1)
Striped Bass	93 (2)	90 (1)	95 (3)		81 (4)	75 (2)	73		93 (2)	84 (1)			89 (1)	86 (1)		
Black Crappie	108		78						131	95 (2)	96 (7)			101 (3)	91 (4)	
Flathead Catfish	109 (7)	114				89 (3)				108 (5)			117	99 (3)		

Appendix 16a. Mean length at age (SE) and average annual growth (SE) for white bass age classes collected from Lake Pleasant in 2003.

Year Class	Age	n	1st Year	2nd Year	3rd Year	4th Year	5th Year
Back-Calculated Length (mm)							
2002	1	8	256 (7.8)				
2001	2	8	213 (4.4)	316 (7.3)			
2000	3	3	217 (18.7)	298 (10.4)	360 (8.0)		
1999	4	9	209 (5.7)	273 (4.8)	322 (3.9)	365 (4.6)	
1998	5	3	213 (16.6)	273 (1.3)	308 (4.7)	344 (1.2)	382 (5.2)
All Classes			223 (4.9)	291 (5.3)	327 (5.4)	360 (4.4)	382 (5.2)
Average Annual Growth (mm)							
2002	1	8	256 (7.8)				
2001	2	8	213 (4.4)	103 (6.0)			
2000	3	3	217 (18.7)	82 (13.4)	61 (8.4)		
1999	4	9	209 (5.7)	64 (4.3)	49 (2.1)	43 (1.9)	
1998	5	3	213 (16.6)	61 (15.5)	34 (5.9)	36 (4.3)	38 (4.5)
All Classes			223 (4.9)	79 (5.2)	49 (3.1)	41 (1.9)	38 (4.5)

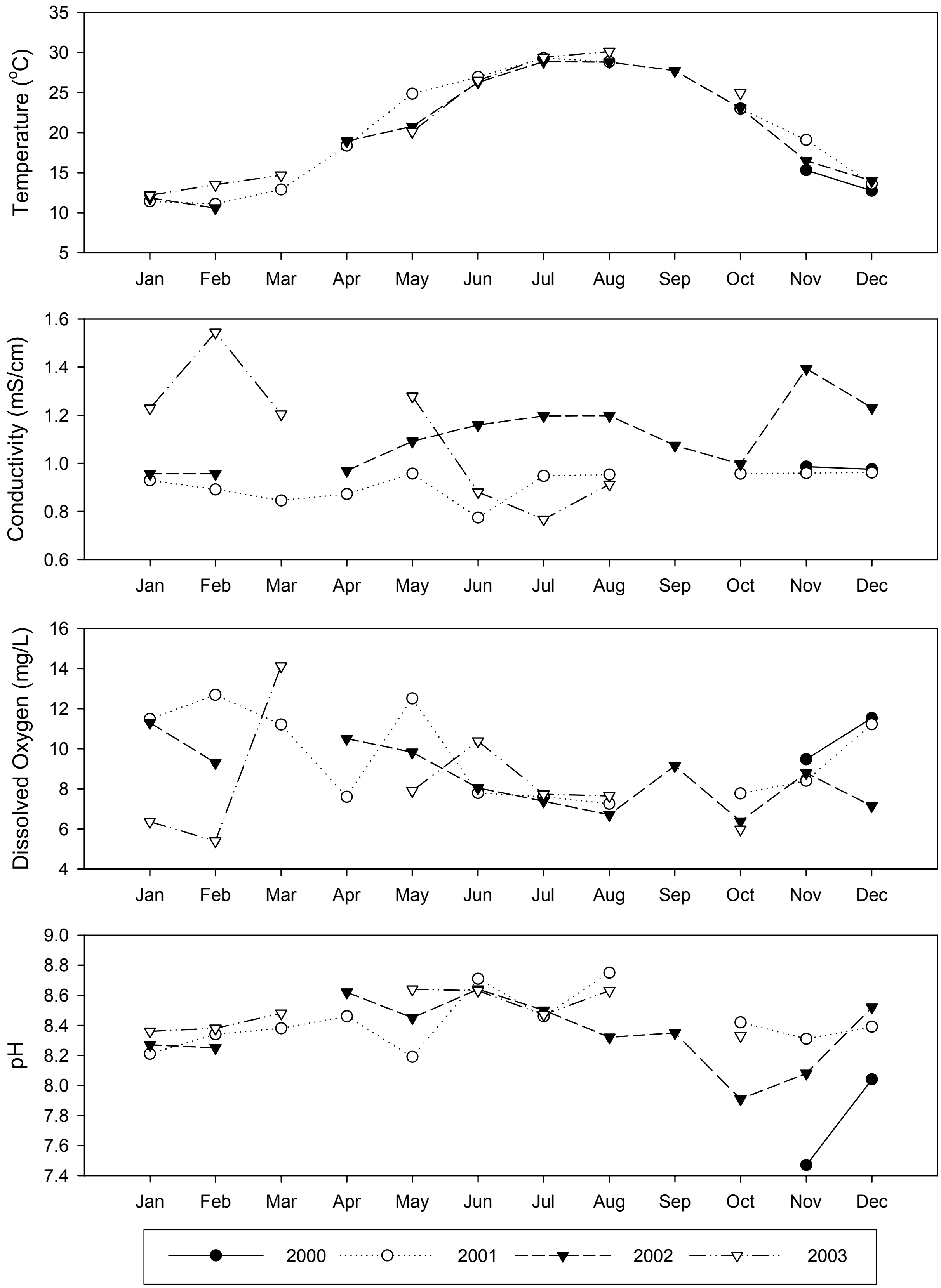
Appendix 16b. Mean length at age (SE) and average annual growth (SE) for largemouth bass age classes collected from Lake Pleasant in 2003.

Year Class	Age	n	1st Year	2nd Year	3rd Year	4th Year	5th Year
Back-Calculated Length (mm)							
2002	1	14	220 (10.2)				
2001	2	1	220 (0)	286 (0)			
2000	3	3	201 (3.1)	271 (11.8)	332 (15.0)		
1999	4	0	--- (---)	--- (---)	--- (---)	--- (---)	
1998	5	1	222 (0)	280 (0)	316 (0)	353 (0)	380 (0)
All Classes			217 (7.6)	276 (7.1)	328 (11.3)	353 (0)	380 (0)
Average Annual Growth (mm)							
2002	1	14	220 (10.2)				
2001	2	1	220 (0)	66 (0)			
2000	3	3	201 (3.1)	70 (10.4)	61 (3.5)		
1999	4	0	--- (---)	--- (---)	--- (---)	--- (---)	
1998	5	1	222 (0)	58 (0)	36 (0)	37 (0)	27 (0)
All Classes			217 (7.6)	66 (6.1)	55 (6.7)	37 (0)	27 (0)

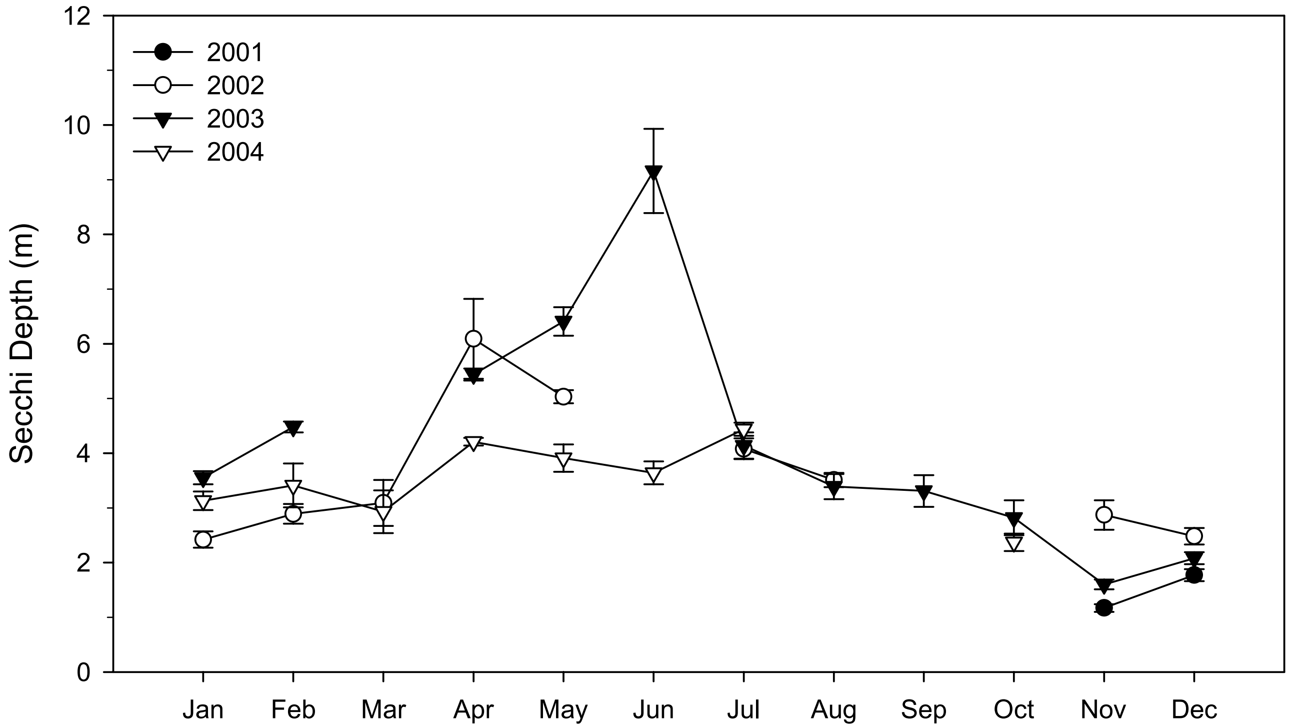
Appendix 16c. Mean length at age (SE) and average annual growth (SE) for striped bass age classes collected from Lake Pleasant in 2003.

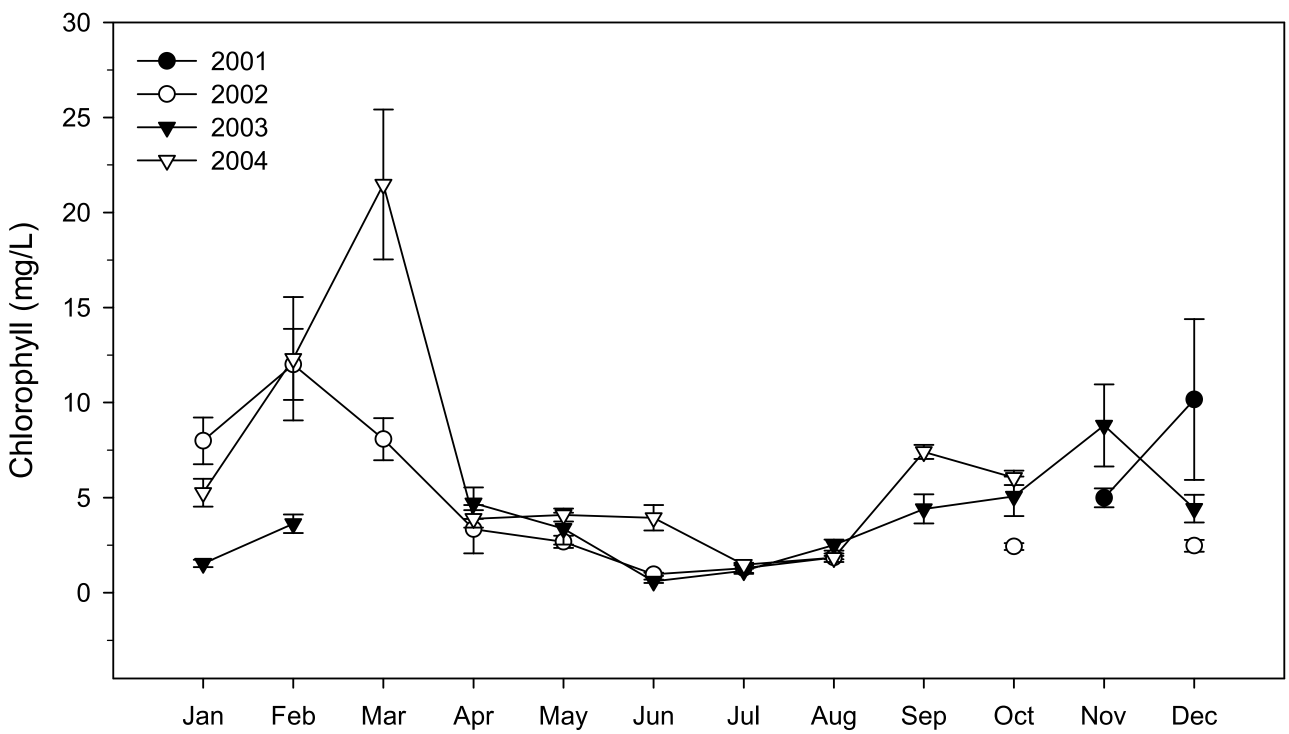
Year Class	Age	n	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year
Back-Calculated Length (mm)								
2002	1	8	318 (31.4)					
2001	2	6	372 (24.3)	484 (30.9)				
2000	3	1	335 (0)	456 (0)	534 (0)			
1999	4	1	312 (0)	394 (0)	521 (0)	605 (0)		
1998	5	0	--- (---)	--- (---)	--- (---)	--- (---)	--- (---)	
1997	6	1	378 (0)	440 (0)	505 (0)	553 (0)	584 (0)	614 (0)
All Classes			341 (17.7)	466 (22.6)	520 (8.4)	579 (25.8)	584 (0)	614 (0)
Average Annual Growth (mm)								
2002	1	8	318 (31.4)					
2001	2	6	372 (24.3)	112 (15.3)				
2000	3	1	335 (0)	121 (0)	78 (0)			
1999	4	1	312 (0)	81 (0)	128 (0)	83 (0)		
1998	5	0	--- (---)	--- (---)	--- (---)	--- (---)	--- (---)	
1997	6	1	378 (0)	61 (0)	65 (0)	48 (0)	31 (0)	30 (0)
All Classes			341 (17.7)	104 (11.8)	91 (19.0)	66 (17.8)	31 (0)	30 (0)

Appendix 17. Mean monthly surface water quality at Lake Pleasant, 2001-2003.



Appendix 18. Mean monthly chlorophyll (mg/L) and secchi depth (m) at Lake Pleasant, 2001-2003.





Appendix 19a. Water chemistry data collected by Central Arizona Project (CAP), Lake Pleasant 2000-2001.

	03/02/2000	06/12/2000	09/13/2000	10/06/2000	02/05/2001	04/04/2001	05/21/2001	07/11/2001
Alkalinity (mg/l)	129	135	121	126	131	131	126	122
Potassium (mg/l)	4.49	4.8	5		4.5		4.5	4.9
Barium (mg/l)	0.098	0.095	0.098		0.13		0.1	0.075
Sodium (mg/l)	86.8	91	94		81		83	87
Calcium (mg/l)	72.5	74	71	73	72	69	72	70
Chloride (mg/l)	79.0	83.9	87.4	85.2	62.7	73	74	78
Copper (mg/l)	<0.010	<0.010	<0.010	<0.010	No Detect		No Detect	No Detect
Iron (total) (mg/l)	<0.10	<0.10	<0.10	<0.10	27	No Detect	1.1	No Detect
Iron (ferrous) (mg/l)	0.1	<0.050	<0.050					<0.10
Magnesium (mg/l)	28.4	29	30	31	No Detect	26	28	28
Manganese (mg/l)	<0.015	<0.015	<0.015	<0.015	No Detect	No Detect	0.025	No Detect
Silica (mg/l)	9.1	8.1	7.6				12	10
Strontium (mg/l)	1.00	1.20	1.10		1.2			0.9
Total Phosphorus P (mg/l)	<0.020	<0.020	<0.020		No Detect		No Detect	No Detect
Ortho Phosphate P (mg/l)	<0.010	<0.010	<0.010		0.01		No Detect	No Detect
Ammonia Nitrogen (mg/l)	<0.050	<0.050	<0.050		No Detect		No Detect	No Detect
Nitrate-NO3 (mg/l)	<0.88		<0.88		No Detect		No Detect	No Detect
Nitrate-N (mg/l)	<0.20	<0.10	<0.20		No Detect		No Detect	No Detect
Sulfate (mg/l)	249	260	267	257	211	230	231	246
Specific Conductance (uS/cm)	900	865	970	970	895	870	814	864
Total Dissolved Solids (mg/l)	550	630	670	670	610	600		630
Turbidity (NTU)	0.6	0.5	1.4	0.20	3.7	1.6	7	0.5
Heavy Metals								
Arsenic	0.0045	0.0044	0.0051		10			3.4
Cadmium	No Detect	No Detect	No Detect		No Detect		No Detect	No Detect

	03/02/2000	06/12/2000	09/13/2000	10/06/2000	02/05/2001	04/04/2001	05/21/2001	07/11/2001
Chromium	0.017	0.007	0.0075		No Detect		No Detect	No Detect
Lead	No Detect	No Detect	No Detect		No Detect		No Detect	No Detect
Selenium	No Detect	No Detect	No Detect		No Detect		No Detect	No Detect
Silver	No Detect	No Detect	No Detect		No Detect		No Detect	No Detect
Mercury	0.0004	No Detect	No Detect		No Detect		0.22	No Detect
Volatile Organic Compounds EPA 524.2								
1,2,4-trimethylbenzene	No Detect	0.0007	No Detect		No Detect		No Detect	No Detect
Benzene	No Detect	0.0005	No Detect		No Detect		No Detect	No Detect
m,p-xylenes	No Detect	0.0015	No Detect		No Detect		No Detect	No Detect
methyltertbutyl ether	No Detect	0.0083	0.0044		No Detect		No Detect	No Detect
o-xylene	No Detect	0.0006	No Detect		No Detect		No Detect	No Detect
toluene	No Detect	0.0018	No Detect		No Detect		No Detect	No Detect
Semi-VOC's EPA 525.2								
diethylphthalate	0.0023	No Detect	No Detect		No Detect		No Detect	1.4
Aldicarbs EPA 531.1	No Detect	No Detect	No Detect					
Herbicides EPA 515.1	No Detect	No Detect	No Detect					
1,1,1,2-Tetrachloroethane					No Detect		No Detect	No Detect
1,1,1-Trichloroethane					No Detect	No Detect	No Detect	No Detect
1,1,2,2-Tetrachloroethane					No Detect		No Detect	No Detect
1,1,2-Trichloroethane					No Detect		No Detect	No Detect
1,1-Dichloroethane					No Detect		No Detect	No Detect
1,1-Dichloroethylene					No Detect	No Detect	No Detect	No Detect
1,1-Dichloropropene					No Detect		No Detect	No Detect
1,2,3-Trichlorobenzene					No Detect		No Detect	No Detect
1,2,3-Trichloropropane					No Detect		No Detect	No Detect

	03/02/2000	06/12/2000	09/13/2000	10/06/2000	02/05/2001	04/04/2001	05/21/2001	07/11/2001
1,2,4-Trichlorobenzene					No Detect		No Detect	No Detect
1,2-Dichloroethane					No Detect	No Detect	No Detect	No Detect
1,2-Dichloropropane					No Detect		No Detect	No Detect
1,3,5-Trimethylbenzene					No Detect		No Detect	No Detect
1,3-Dichloropropane					No Detect		No Detect	No Detect
2,2-Dichloropropane					No Detect		No Detect	No Detect
2,4,5-T					No Detect		No Detect	No Detect
2,4,5-TP (Silvex)					No Detect		No Detect	No Detect
2,4-D					No Detect		No Detect	No Detect
2,4-DB					No Detect		No Detect	No Detect
2,4-Dinitrotoluene					No Detect	No Detect	No Detect	No Detect
2-Butanone (MEK)					No Detect		No Detect	No Detect
3,5-Dichlorobenzoic acid					No Detect		No Detect	No Detect
3-Hydroxycarbofuran					No Detect		No Detect	No Detect
4-Methyl-2-Pentanone (MIBK)					No Detect		No Detect	No Detect
4-Nitrophenol (qualitative)					No Detect		No Detect	No Detect
Acenaphthylene					No Detect	No Detect	No Detect	No Detect
Acifluorfen (qualitative)					No Detect		No Detect	No Detect
Alachlor					No Detect	No Detect	No Detect	No Detect
Aldicarb (Temik)					No Detect		No Detect	No Detect
Aldicarb sulfone					No Detect		No Detect	No Detect
Aldicarb sulfoxide					No Detect		No Detect	No Detect
Aldrin					No Detect	No Detect	No Detect	No Detect
alpha-Chlordane					No Detect	No Detect	No Detect	No Detect
Anthracene					No Detect	No Detect	No Detect	No Detect
Atrazine					No Detect	No Detect	No Detect	No Detect
Baygon					No Detect		No Detect	No Detect
Bentazon					No Detect		No Detect	No Detect
Benz(a)Anthracene					No Detect	No Detect	No Detect	No Detect

	03/02/2000	06/12/2000	09/13/2000	10/06/2000	02/05/2001	04/04/2001	05/21/2001	07/11/2001
Benzo(a)pyrene					No Detect	No Detect	No Detect	No Detect
Benzo(b)Fluoranthene					No Detect	No Detect	No Detect	No Detect
Benzo(g,h,i)Perylene					No Detect	No Detect	No Detect	No Detect
Benzo(k)Fluoranthene					No Detect	No Detect	No Detect	No Detect
Bromacil					No Detect	No Detect	No Detect	No Detect
Bromobenzene					No Detect	No Detect	No Detect	No Detect
Bromochloromethane					No Detect		No Detect	No Detect
Bromodichloromethane					No Detect	No Detect	No Detect	No Detect
Bromoform					No Detect	No Detect	No Detect	No Detect
Bromomethane (Methyl Bromide)					No Detect	No Detect	No Detect	No Detect
Butachlor					No Detect	No Detect	No Detect	No Detect
Butylbenzylphthalate					No Detect	No Detect	No Detect	No Detect
Caffeine					No Detect	No Detect	No Detect	No Detect
Carbaryl					No Detect		No Detect	No Detect
Carbofuran (Furadan)					No Detect		No Detect	No Detect
Carbon Tetrachloride					No Detect	No Detect	No Detect	No Detect
Chlorobenzene					No Detect	No Detect	No Detect	No Detect
Chlorodibromomethane					No Detect	No Detect	No Detect	No Detect
Chloroethane					No Detect	No Detect	No Detect	No Detect
Chloroform (Trichloromethane)					No Detect	No Detect	No Detect	No Detect
Chloromethane(Methyl Chloride)					No Detect	No Detect	No Detect	No Detect
Chrysene					No Detect	No Detect	No Detect	No Detect
cis-1,2-Dichloroethylene					No Detect	No Detect	No Detect	No Detect
cis-1,3-Dichloropropene					No Detect		No Detect	No Detect
Dalapon (qualitative)					No Detect		No Detect	No Detect
Di-(2-Ethylhexyl)adipate					No Detect	No Detect	No Detect	No Detect
Di(2-Ethylhexyl)phthalate					No Detect	No Detect	No Detect	No Detect
Dibenz(a,h)Anthracene					No Detect	No Detect	No Detect	No Detect
Dibromomethane					No Detect	No Detect	No Detect	No Detect

	03/02/2000	06/12/2000	09/13/2000	10/06/2000	02/05/2001	04/04/2001	05/21/2001	07/11/2001
Dicamba					No Detect		No Detect	No Detect
Dichlorodifluoromethane					No Detect		No Detect	No Detect
Dichloromethane					No Detect		No Detect	No Detect
Dichlorprop					No Detect		No Detect	No Detect
Dieldrin					No Detect	No Detect	No Detect	No Detect
Di-isopropyl ether					No Detect		No Detect	No Detect
Dimethoate					No Detect	No Detect	No Detect	No Detect
Dimethylphthalate					No Detect	No Detect	No Detect	No Detect
Di-n-Butylphthalate					No Detect	No Detect	No Detect	No Detect
Dinoseb					No Detect		No Detect	No Detect
Endrin					No Detect	No Detect	No Detect	No Detect
Ethyl benzene					No Detect		No Detect	No Detect
Fluoranthene					No Detect	No Detect	No Detect	No Detect
Fluorene					No Detect	No Detect	No Detect	No Detect
Fluorotrichloromethane-Freon11					No Detect		No Detect	No Detect
gamma-Chlordane					No Detect	No Detect	No Detect	No Detect
Heptachlor					No Detect	No Detect	No Detect	No Detect
Heptachlor Epoxide					No Detect	No Detect	No Detect	No Detect
Hexachlorobenzene					No Detect	No Detect	No Detect	No Detect
Hexachlorobutadiene					No Detect		No Detect	No Detect
Hexachlorocyclopentadiene					No Detect	No Detect	No Detect	No Detect
Indeno(1,2,3,c,d)Pyrene					No Detect	No Detect	No Detect	No Detect
Isophorone					No Detect	No Detect	No Detect	No Detect
Isopropylbenzene					No Detect		No Detect	No Detect
Lindane					No Detect	No Detect	No Detect	No Detect
m-Dichlorobenzene (1,3-DCB)					No Detect	No Detect	No Detect	No Detect
Methiocarb					No Detect		No Detect	No Detect
Methomyl					No Detect		No Detect	No Detect
Methoxychlor					No Detect	No Detect	No Detect	No Detect

	03/02/2000	06/12/2000	09/13/2000	10/06/2000	02/05/2001	04/04/2001	05/21/2001	07/11/2001
Metolachlor					No Detect	No Detect	No Detect	No Detect
Metribuzin					No Detect	No Detect	No Detect	No Detect
Molinate					No Detect	No Detect	No Detect	No Detect
Naphthalene					No Detect		No Detect	No Detect
n-Butylbenzene					No Detect		No Detect	No Detect
Nitrobenzene					No Detect		No Detect	
n-Propylbenzene					No Detect		No Detect	No Detect
o-Chlorotoluene					No Detect	No Detect	No Detect	No Detect
o-Dichlorobenzene (1,2-DCB)					No Detect	No Detect	No Detect	No Detect
Oxamyl (Vydate)					No Detect		No Detect	No Detect
p-Chlorotoluene					No Detect	No Detect	No Detect	No Detect
p-Dichlorobenzene (1,4-DCB)					No Detect	No Detect	No Detect	No Detect
Pentachlorophenol					No Detect	No Detect	No Detect	No Detect
Pentachlorophenol					No Detect		No Detect	No Detect
Perylene-d12					74	No Detect	No Detect	
Phenanthrene					No Detect	No Detect	No Detect	No Detect
Picloram					No Detect		No Detect	No Detect
p-Isopropyltoluene					No Detect		No Detect	No Detect
Prometryn					No Detect	No Detect	No Detect	No Detect
Propachlor					No Detect	No Detect	No Detect	No Detect
Pyrene					No Detect	No Detect	No Detect	No Detect
sec-Butylbenzene					No Detect		No Detect	No Detect
Simazine					No Detect	No Detect	No Detect	No Detect
Styrene					No Detect		No Detect	No Detect
tert-amyl Methyl Ether					No Detect		No Detect	No Detect
tert-Butyl Ethyl Ether					No Detect		No Detect	No Detect
tert-Butylbenzene					No Detect		No Detect	No Detect
Tetrachloroethylene (PCE)					No Detect		No Detect	No Detect
Thiobencarb					No Detect	No Detect	No Detect	No Detect

	03/02/2000	06/12/2000	09/13/2000	10/06/2000	02/05/2001	04/04/2001	05/21/2001	07/11/2001
Tot DCPA Mono&Diacid Degradate					No Detect		No Detect	No Detect
Total THM					No Detect		No Detect	No Detect
Total xylenes					No Detect		No Detect	No Detect
trans-1,2-Dichloroethylene					No Detect	No Detect	No Detect	No Detect
trans-1,3-Dichloropropene					No Detect		No Detect	No Detect
trans-Nonachlor					No Detect	No Detect	No Detect	No Detect
Trichloroethylene (TCE)					No Detect	No Detect	No Detect	No Detect
Trichlorotrifluoroethane(Freon					No Detect		No Detect	No Detect
Trifluralin					No Detect	No Detect	No Detect	No Detect
Vinyl chloride (VC)					No Detect	No Detect	No Detect	No Detect

Appendix 19b. Water chemistry data collected by Central Arizona Project (CAP), Lake Pleasant 2002-2003.

	01/14/2002	05/29/2002	07/09/2002	10/9/2002	2/20/2003	5/14/2003	2/10/2004	5/12/2004	8/10/2004
Alkalinity (mg/l)	132	126	127	127	135	130	128	124	118
Potassium (mg/l)	4.6	5	5.2	5.1	4.5	4.5	4.7	4.8	5.1
Barium (mg/l)	0.098	No Detect	No Detect	0.081	0.11	0.095	0.13	0.13	0.12
Sodium (mg/l)	85	91	98	91	88	91	98	98	100
Calcium (mg/l)	73	69	72	65	70	70	72	74	73
Chloride (mg/l)	76	79	82	87	84	79	90	83	93
Copper (mg/l)	No Detect	0.16	0.09	No Detect	No Detect	No Detect	No detect	No detect	No detect
Iron (total) (mg/l)	No Detect	0.42	No Detect	0.24	No Detect	No Detect	0.044	No detect	No detect
Iron (ferrous) (mg/l)	No Detect	0.25	No Detect	No Detect	No Detect	No Detect	No detect	No detect	
Magnesium (mg/l)	29	29	31	29	28	30	30	31	33
Manganese (mg/l)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	0.007	No detect	No detect
Silica (mg/l)	11	12	9.5	11	9.5	10	9.8	8.2	8.5
Strontium (mg/l)	1.1	0.97	0.89	1	1	0.95	1.1	1.1	1.1
Total Phosphorus P (mg/l)	No Detect	No Detect	No Detect	0.04	No Detect	No Detect	No detect	No detect	No detect
Ortho Phosphate P (mg/l)	0.08	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Ammonia Nitrogen (mg/l)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Nitrate-NO3 (mg/l)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Nitrate-N (mg/l)	0.1	No Detect	No Detect	No Detect	No Detect	No Detect	0.19	No detect	No detect
Sulfate (mg/l)	238	240	260	265	250	240	260	250	260
Specific Conductance (uS/cm)	912	902	937	1010	970	947	1010	998	1030
Total Dissolved Solids (mg/l)	620	650	640	640	670	630	660	650	690
Turbidity (NTU)	1.1	7.6	1.6	1.3	2.4	1.3	1	1	0.55
Heavy Metals									
Arsenic	3.7	3.4	3.4	5.6	3.4	3.2	2.9	3	2.9
Cadmium	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Chromium	No Detect	1.6	1.2	1.8	No Detect	No Detect	No detect	2.3	No detect
Lead	No Detect	4.2	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect

	01/14/2002	05/29/2002	07/09/2002	10/9/2002	2/20/2003	5/14/2003	2/10/2004	5/12/2004	8/10/2004
Selenium	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Silver	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Mercury	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Volatile Organic Compounds EPA 524.2									
1,2,4-trimethylbenzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Benzene	No Detect	No Detect	0.5	No Detect	No Detect	No Detect	No detect	No detect	No detect
m,p-xylenes	No Detect	No Detect	0.6	No Detect	No Detect	No Detect	No detect	No detect	No detect
methyltertbutyl ether (MTBE)	No Detect	No Detect	4.2	No Detect	No Detect	No Detect	No detect	No detect	No detect
o-xylene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
toluene	No Detect	No Detect	1	No Detect	No Detect	No Detect	No detect	No detect	No detect
Semi-VOC's EPA 525.2									
diethylphthalate	1	No Detect	1.9	0.9	No Detect	3.7	No detect	No detect	No detect
1,1,1,2-Tetrachloroethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,1,1-Trichloroethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,1,2,2-Tetrachloroethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,1,2-Trichloroethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,1-Dichloroethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,1-Dichloroethylene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,1-Dichloropropene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,2,3-Trichlorobenzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,2,3-Trichloropropane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,2,4-Trichlorobenzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,2-Dichloroethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,2-Dichloropropane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,3,5-Trimethylbenzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
1,3-Dichloropropane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
2,2-Dichloropropane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
2,4,5-T	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect

	01/14/2002	05/29/2002	07/09/2002	10/9/2002	2/20/2003	5/14/2003	2/10/2004	5/12/2004	8/10/2004
2,4,5-TP (Silvex)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
2,4-D	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
2,4-DB	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
2,4-Dinitrotoluene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
2-Butanone (MEK)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
3,5-Dichlorobenzoic acid	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
3-Hydroxycarbofuran	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
4-Methyl-2-Pentanone (MIBK)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
4-Nitrophenol (qualitative)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Acenaphthylene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Acifluorfen (qualitative)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Alachlor	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Aldicarb (Temik)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Aldicarb sulfone	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Aldicarb sulfoxide	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Aldrin	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
alpha-Chlordane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Anthracene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Atrazine	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Baygon	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Bentazon	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Benz(a)Anthracene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Benzo(a)pyrene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Benzo(b)Fluoranthene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Benzo(g,h,i)Perylene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Benzo(k)Fluoranthene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Bromacil	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Bromobenzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Bromochloromethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Bromodichloromethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Bromoform	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect

	01/14/2002	05/29/2002	07/09/2002	10/9/2002	2/20/2003	5/14/2003	2/10/2004	5/12/2004	8/10/2004
Bromomethane (Methyl Bromide)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Butachlor	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Butylbenzylphthalate	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Caffeine	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Carbaryl	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Carbofuran (Furadan)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Carbon Tetrachloride	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Chlorobenzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Chlorodibromomethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Chloroethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Chloroform (Trichloromethane)	No Detect	0.6	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Chloromethane(Methyl Chloride)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Chrysene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
cis-1,2-Dichloroethylene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
cis-1,3-Dichloropropene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Dalapon (qualitative)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Di-(2-Ethylhexyl)adipate	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Di(2-Ethylhexyl)phthalate	0.9	2.6	No Detect	No Detect	No Detect	No Detect	No detect	No detect	1.43
Dibenz(a,h)Anthracene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Dibromomethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Dicamba	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Dichlorodifluoromethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Dichloromethane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Dichlorprop	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Dieldrin	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Di-isopropyl ether	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Dimethoate	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Dimethylphthalate	No Detect	6	No Detect	No Detect	No Detect	No Detect			
Di-n-Butylphthalate	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Dinoseb	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Endrin	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect

	01/14/2002	05/29/2002	07/09/2002	10/9/2002	2/20/2003	5/14/2003	2/10/2004	5/12/2004	8/10/2004
Ethyl benzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Fluoranthene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Fluorene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Fluorotrichloromethane-Freon11	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
gamma-Chlordane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Heptachlor	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Heptachlor Epoxide	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Hexachlorobenzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Hexachlorobutadiene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Hexachlorocyclopentadiene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Indeno(1,2,3,c,d)Pyrene	No Detect	No Detect	No Detect	No Detect	0.08	No Detect			
Isophorone	No Detect	No Detect	3.6	No Detect	No Detect	No Detect			
Isopropylbenzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Lindane	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
m-Dichlorobenzene (1,3-DCB)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Methiocarb	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Methomyl	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Methoxychlor	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Metolachlor	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Metribuzin	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Molinate	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Naphthalene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
n-Butylbenzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Nitrobenzene	No Detect	No Detect	No Detect						
n-Propylbenzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
o-Chlorotoluene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
o-Dichlorobenzene (1,2-DCB)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Oxamyl (Vydate)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
p-Chlorotoluene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
p-Dichlorobenzene (1,4-DCB)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	0.7	No detect
Pentachlorophenol	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect

	01/14/2002	05/29/2002	07/09/2002	10/9/2002	2/20/2003	5/14/2003	2/10/2004	5/12/2004	8/10/2004
Pentachlorophenol	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Phenanthrene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Picloram	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
p-Isopropyltoluene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Prometryn	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Propachlor	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Pyrene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
sec-Butylbenzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Simazine	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Styrene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
tert-amyl Methyl Ether	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
tert-Butyl Ethyl Ether	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
tert-Butylbenzene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Tetrachloroethylene (PCE)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Thiobencarb	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Tot DCPA Mono&Diacid Degradate	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Total THM	No Detect	0.6	No Detect	No Detect	No Detect	No Detect			
Total xylenes	No Detect	No Detect	0.6	No Detect	No Detect	No Detect	No detect	No detect	No detect
trans-1,2-Dichloroethylene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
trans-1,3-Dichloropropene	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
trans-Nonachlor	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Trichloroethylene (TCE)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Trichlorotrifluoroethane(Freon	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect			
Trifluralin	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect
Vinyl chloride (VC)	No Detect	No Detect	No Detect	No Detect	No Detect	No Detect	No detect	No detect	No detect

Appendix 20. Mean monthly chlorophyll (mg/L) and secchi depth (m) at Lake Pleasant during Phase I and Phase II.